

CMMI® for Acquisition, Version 1.2

CMMI-ACQ, V1.2

CMMI Product Team

Improving processes for acquiring better products and services

November 2007

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Preface

CMMI® (Capability Maturity Model® Integration) models are collections of best practices that help organizations improve their processes. The first CMMI model was developed by a product team from industry, government, and the Software Engineering Institute (SEI) for the application of process improvement in the development of products and services covering the entire product lifecycle from conceptualization through maintenance and disposal. Following the success of CMMI models for development organizations, the need was identified for a CMMI model addressing the acquisition environment.

General Motors, in collaboration with the SEI and with approval of the CMMI Sponsors and Steering Group, developed the initial draft of the Acquisition constellation as the special report, *Adapting CMMI for Acquisition Organizations: A Preliminary Report* [Dodson 2006].¹ CMMI for Acquisition, Version 1.2 (CMMI-ACQ, V1.2) reflects the refinement of this initial draft. The CMMI-ACQ development team, consisting of members from government, industry, and the SEI, gathered input from those who piloted and reviewed the preliminary report and created CMMI-ACQ, V1.2. This model is included in the CMMI Product Suite.

Purpose

The CMMI-ACQ, V1.2 model is a collection of best practices that is generated from the CMMI V1.2 Architecture and Framework. This collection includes acquisition best practices from government and industry. CMMI-ACQ is based on the CMMI Model Foundation or CMF (i.e., model components common to all CMMI models and constellations), the CMMI Acquisition Module [Bernard 2005], and the Software Acquisition Capability Maturity Model (SA-CMM) [SEI 2002]. CMMI-ACQ also incorporates work by several acquisition organizations to adapt the Development constellation for use in an acquisition organization.

¹ A *constellation* is a collection of components used to construct models, training materials, and appraisal materials in an area of interest (e.g., acquisition and development).

The CMMI-ACQ model provides guidance for the application of CMMI best practices by the acquirer. Best practices in the model focus on activities for initiating and managing the acquisition of products and services that meet the needs of the customer. Although suppliers may provide artifacts useful to the processes addressed in CMMI-ACQ, the focus of the model is on the processes of the acquirer. CMMI-ACQ integrates bodies of knowledge that are essential for an acquirer.

By integrating these bodies of knowledge, CMMI-ACQ provides a comprehensive set of best practices for acquiring products and services. CMMI for Development (CMMI-DEV) may be treated as a reference for supplier-executed activities for systems engineering, software development, and hardware design work in an acquisition initiative [SEI 2006a]. In those cases where the acquirer also has a role as a product or service developer (e.g., taking responsibility for the first few layers of product development and integration), CMMI-DEV (in particular the Requirements Development, Technical Solution, and Product Integration process areas) should also be used to improve the acquirer's product or service development processes.

Acknowledgements

Many talented people were involved in the development of the CMMI v1.2 Product Suite. Three primary groups involved in this development were the Steering Group, Product Team, and Configuration Control Board.

The Steering Group guided and approved plans of the Product Team, provided consultation on significant CMMI project issues, and ensured involvement from a variety of interested communities.

The Steering Group initiated the development of the Acquisition constellation, recognizing the importance of providing best practices to acquirers. The Steering Group provided guidance for the development of the CMMI-ACQ model and its accompanying training materials.

The Product Team wrote, reviewed, revised, discussed, and agreed on the structure and technical content of the CMMI Product Suite, including the framework, models, training, and appraisal materials. Development activities were based on multiple inputs. These inputs included an A-Specification and guidance specific to each release provided by the Steering Group, source models, change requests received from the user community, and input received from pilots and other stakeholders.

The CMMI Configuration Control Board (CCB) is the official mechanism for controlling changes to CMMI models and *Introduction to CMMI* training. As such, this group ensures integrity over the life of the product suite by reviewing all proposed changes to the baseline and approving only those changes that satisfy identified issues and meet criteria for the upcoming release.

The Acquisition Advisory Board acted as the configuration control board for the Acquisition constellation, approving all changes to the Acquisition constellation. Consisting of experts in the field of acquisition, this group ensured the integrity of the constellation using the same review process as the CMMI CCB.

Members of the groups involved in developing CMMI-ACQ, V1.2 are listed in Appendix C.

Audience

The audience for CMMI-ACQ is anyone interested in process improvement in an acquisition environment. Whether you are familiar with the concept of Capability Maturity Models or are seeking information to get started on your improvement efforts, CMMI-ACQ will be useful to you. This model is also intended for organizations who want to use a reference model for an appraisal of their acquisition-related processes.²

Organization of this Document

This document is organized into three main parts:

- Part One—About CMMI for Acquisition
- Part Two—Generic Goals and Generic Practices, and the Process Areas
- Part Three—The Appendices and Glossary

Part One, “About CMMI for Acquisition,” consists of five chapters:

- Chapter 1, “Introduction,” offers a broad view of CMMI and the Acquisition constellation, concepts of process improvement, the history of models used for process improvement, and different process improvement approaches.
- Chapter 2, “Process Area Components,” describes all of the components of the CMMI-ACQ process areas.

² An *appraisal* is an examination of one or more processes by a trained team of professionals using a reference model (e.g., CMMI-ACQ) as the basis for determining strengths and weaknesses.

- Chapter 3, “Tying It All Together,” assembles the model components and explains the concepts of maturity levels and capability levels.
- Chapter 4, “Relationships Among Process Areas,” provides insight into the meaning and interactions of the CMMI-ACQ process areas.
- Chapter 5, “Using CMMI Models,” describes paths to adoption and the use of CMMI-ACQ for process improvement and benchmarking of practices in an acquisition organization.

Part Two, “Generic Goals and Generic Practices, and the Process Areas,” contains all of this CMMI model’s required and expected components. It also contains related informative components, including subpractices, notes, examples, and typical work products.

Part Two contains 23 sections. The first section contains the generic goals and practices. The remaining 22 sections each represent one of the CMMI-ACQ process areas.³

To make these process areas easy to find, they are organized alphabetically by process area acronym. Each section contains descriptions of goals, best practices, and examples.

Part Three, “The Appendices and Glossary,” consists of four sections:

- Appendix A, “References,” contains references you can use to locate documented sources of information such as reports, process improvement models, industry standards, and books that are related to CMMI-ACQ.
- Appendix B, “Acronyms,” defines the acronyms used in the model.
- Appendix C, “CMMI for Acquisition Project Participants,” contains lists of team members and their organizations who participated in the development of CMMI-ACQ, Version 1.2.
- Appendix D, “Glossary,” defines many of the terms used in CMMI-ACQ.

³ A process area is a cluster of related best practices in an area, which when implemented collectively, satisfies a set of goals considered important for making significant improvement in that area. This concept is covered in detail in Chapter 2.

How to Use this Document

Whether you are new to process improvement, new to CMMI, or already familiar with CMMI, Part One can help you understand why CMMI-ACQ is the guide to use for improving your acquisition processes.

Readers New to Process Improvement

If you are new to process improvement or new to the Capability Maturity Model (CMM[®]) concept, we suggest that you read Chapter 1, “Introduction,” first. Chapter 1 contains an overview of process improvement that explains what CMMI is all about.

Next, skim Part Two, including generic goals and practices and specific goals and practices, to get a feel for the scope of the best practices contained in the model. Pay close attention to the purpose and introductory notes at the beginning of each process area.

In Part Three, look through the references in Appendix A and select additional sources you think would be beneficial to read before moving forward with using CMMI-ACQ. Read through the acronyms and glossary to become familiar with the language of CMMI. Then, go back and read the details of Part Two.

Readers Experienced with Process Improvement

If you are new to CMMI but have experience with other process improvement models, such as the Software Acquisition CMM, you will immediately recognize many similarities in their structure and content.

We recommend that you read Part One to understand how CMMI is different from other process improvement models. If you have experience with other models, you may want to select which sections to read first. Read Part Two with an eye for best practices you recognize from the models that you have already used. By identifying familiar material, you will gain an understanding of what is new and what has been carried over, or is familiar from the models you already know.

Next, review the glossary to understand how some terminology may differ from that used in the process improvement models you know. Many concepts are repeated, but they may be called something different.

Readers Familiar with CMMI

If you have reviewed or used a CMMI model before, you will quickly recognize the CMMI concepts discussed and the best practices presented.

Additional Information and Reader Feedback

There are many sources of information about CMMI, such as the background and history of the CMMI models, as well as the benefits of using CMMI models. Many of these sources are listed in Appendix A and are also published on the CMMI Web site—
<http://www.sei.cmu.edu/cmmi/>.

Your suggestions for improving CMMI are welcome. For information on how to provide feedback, see the CMMI Web site at <http://www.sei.cmu.edu/cmmi/models/change-requests.html>. If you have questions about CMMI, send email to cmmi-comments@sei.cmu.edu.

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PART ONE

About CMMI for Acquisition

1 Introduction

Now more than ever, organizations are increasingly becoming acquirers⁴ of needed capabilities by obtaining products and services from suppliers and developing less and less of these capabilities in-house. The intent of this widely adopted business strategy is to improve an organization's operational efficiencies by leveraging suppliers' capabilities to deliver quality solutions rapidly, at lower cost, and with the most appropriate technology.

Acquisition of needed capabilities is challenging because acquirers must take overall accountability for satisfying the user of the needed capability while allowing the supplier to perform the tasks necessary to develop and provide the solution.

According to recent studies, 20 to 25 percent of large information technology (IT) acquisition projects fail within two years and 50 percent fail within five years. Mismanagement, the inability to articulate customer needs, poor requirements definition, inadequate supplier selection and contracting processes, insufficient technology selection procedures, and uncontrolled requirements changes are factors that contribute to project failure. Responsibility is shared by both the supplier and the acquirer. The majority of project failures could be avoided if the acquirer learned how to properly prepare for, engage with, and manage suppliers.

In addition to these challenges, an overall key to a successful acquirer-supplier relationship is communication.

Unfortunately, many organizations have not invested in the capabilities necessary to effectively manage projects in an acquisition environment. Too often acquirers disengage from the project once the supplier is hired. Too late they discover that the project is not on schedule, deadlines will not be met, the technology selected is not viable, and the project has failed.

⁴ In CMMI-ACQ, the terms *project* and *acquirer* refer to the acquisition project; the term *organization* refers to the acquisition organization.

The acquirer has a focused set of major objectives. These objectives include the requirement to maintain a relationship with the final users of the capability to fully comprehend their needs. The acquirer owns the project, executes overall project management, and is accountable for delivering the needed capabilities to the users. Thus, these acquirer responsibilities may extend beyond ensuring the right capability is delivered by chosen suppliers to include such activities as integrating the overall product or service, transitioning it into operation, and obtaining insight into its appropriateness and adequacy to continue to meet customer needs.

CMMI® for Acquisition (CMMI-ACQ) provides an opportunity to avoid or eliminate barriers in the acquisition process through practices and terminology that transcend the interests of individual departments or groups.

This document provides guidance to help the acquirer apply CMMI best practices.

CMMI-ACQ contains 22 process areas. Of those, 16 are CMMI Model Foundation (CMF) process areas that cover process management, project management, and support process areas. More about the CMF is discussed in Chapter 3.

Six process areas focus on practices specific to acquisition addressing agreement management, acquisition requirements development, acquisition technical management, acquisition validation, acquisition verification, and solicitation and supplier agreement development.

All CMMI-ACQ model practices focus on the activities of the acquirer. Those activities include supplier sourcing, developing and awarding supplier agreements, and managing the acquisition of capabilities, including the acquisition of both products and services. Supplier activities are not addressed in this document. Suppliers and acquirers who also develop products and services should consider using the CMMI-DEV model.

About Capability Maturity Models

In its research to help organizations develop and maintain quality products and services, the Software Engineering Institute (SEI) has found several dimensions that an organization can focus on to improve its business. Figure 1.1 illustrates the three critical dimensions that organizations typically focus on: people, procedures and methods, and tools and equipment.

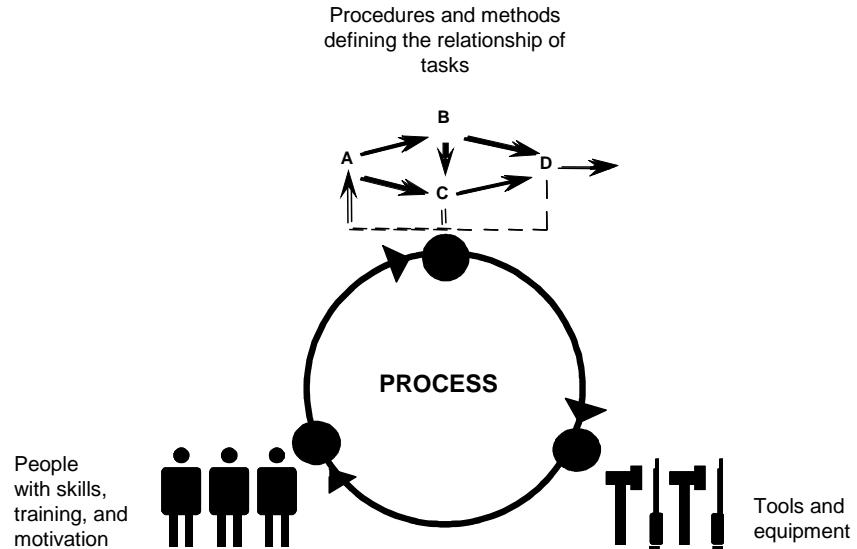


Figure 1.1: The Three Critical Dimensions

But what holds everything together? It is the processes used in your organization. Processes allow you to align the way you do business. They allow you to address scalability and provide a way to incorporate knowledge of how to do things better. Processes allow you to leverage your resources and to examine business trends.

This is not to say that people and technology are not important. We are living in a world where technology is changing by an order of magnitude every ten years. Similarly, people typically work for many companies throughout their careers. We live in a dynamic world. A focus on process provides the infrastructure and stability necessary to deal with an ever-changing world and to maximize the productivity of people and the use of technology to be more competitive.

Manufacturing has long recognized the importance of process effectiveness and efficiency. Today, many organizations in manufacturing and service industries recognize the importance of quality processes. Process helps an organization's workforce meet business objectives by helping them work smarter, not harder, and with improved consistency. Effective processes also provide a vehicle for introducing and using new technology in a way that best meets the business objectives of the organization.

In the 1930s, Walter Shewhart began work in process improvement with his principles of statistical quality control [Shewhart 1931]. These principles were refined by W. Edwards Deming [Deming 1986], Phillip Crosby [Crosby 1979], and Joseph Juran [Juran 1988]. Watts Humphrey, Ron Radice, and others extended these principles even further and began applying them to software in their work at IBM (International Business Machines) and the SEI [Humphrey 1989]. Humphrey's book, *Managing the Software Process*, provides a description of the basic principles and concepts on which many of the Capability Maturity Models® (CMMs®) are based.

The SEI has taken the process management premise, "the quality of a system or product is highly influenced by the quality of the process used to develop and maintain it," and defined CMMs that embody this premise. The belief in this premise is seen worldwide in quality movements, as evidenced by the International Organization for Standardization/International Electrotechnical Commission (ISO/IEC) body of standards.

CMMs focus on improving processes in an organization. They contain the essential elements of effective processes for one or more disciplines and describe an evolutionary improvement path from ad hoc, immature processes to disciplined, mature processes with improved quality and effectiveness.

The SEI created the first CMM designed for software organizations and published it in a book, *Capability Maturity Model: Guidelines for Improving the Software Process* [SEI 1995].

Today, CMMI is an application of the principles introduced almost a century ago to this never-ending cycle of process improvement. The value of this process improvement approach has been confirmed over time. Organizations have experienced increased productivity and quality, improved cycle time, and more accurate and predictable schedules and budgets [Gibson 2006].

Evolution of CMMI

Figure 1.2 illustrates the models that were integrated into CMMI-DEV and CMMI-ACQ. Developing a set of integrated models involved more than simply combining existing model materials. Using processes that promote consensus, the CMMI Product Team built a framework that accommodates multiple constellations.

History of CMMs

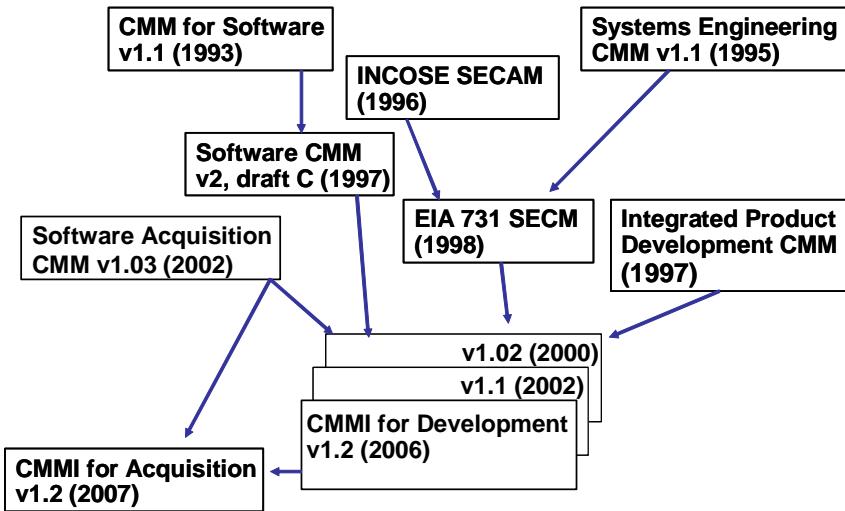


Figure 1.2: The History of CMMs⁵

CMMI Framework Architecture

The CMMI Framework Architecture provides the structure needed to produce CMMI models, training, and appraisal components. To allow the use of multiple models within the CMMI Framework, model components are classified as either common to all CMMI models or applicable to a specific model. The common material is called the *CMMI Model Foundation* or *CMF*.

The components of the CMF are required to be a part of every model generated from the framework. Those components are combined with material applicable to an area of interest to produce a model. Some of this material is shared among areas of interest and others are unique to only one area of interest.

A *constellation* is defined as a collection of components that are used to construct models, training materials, and appraisal materials in an area of interest (e.g., acquisition and development). The Acquisition constellation's model is called *CMMI for Acquisition* or *CMMI-ACQ*.

⁵ EIA 731 SECM is the Electronic Industries Alliance standard 731, or the Systems Engineering Capability Model. INCOSE SECAM is International Council on Systems Engineering Systems Engineering Capability Assessment Model [EIA 2002].

The CMMI Steering Group initially approved an introductory collection of acquisition best practices called the *Acquisition Module* (CMMI-AM), which was based on the CMMI Framework. While it sought to capture best practices, it was not intended to become an appraisable model nor a suitable model for process improvement purposes.

General Motors partnered with the SEI to create the initial draft Acquisition model that was the basis for this model. This model represents the work of many organizations and individuals.

Acquirers should use professional judgment and common sense to interpret this model for their organizations. That is, although the process areas described in this model depict behaviors considered best practice for most acquirers, all process areas and practices should be interpreted using an in-depth knowledge of CMMI-ACQ, organizational constraints, and the business environment.

This document is a reference model that covers the acquisition of needed capabilities. Capabilities are acquired in many industries, including aerospace, banking, computer hardware, software, defense, automobile manufacturing, and telecommunications. All these industries can use CMMI-ACQ.

2 Process Area Components

This chapter describes the components found in each process area, and in the generic goals and generic practices. Understanding the meaning of these components is critical to using the information in Part Two effectively. If you are unfamiliar with Part Two, you may want to skim the “Generic Goals and Generic Practices” section and a couple of process area sections to get a general feel for the content and layout before reading this chapter.

Required, Expected, and Informative Components

Model components are grouped into three categories—required, expected, and informative—that reflect how to interpret them.

Required Components

Required components describe what an organization must achieve to satisfy a process area. This achievement must be visibly implemented in an organization’s processes. The required components in CMMI are the specific and generic goals. Goal satisfaction is used in appraisals as the basis for deciding whether a process area has been satisfied.

Expected Components

Expected components describe what an organization may implement to achieve a required component. Expected components guide those who implement improvements or perform appraisals. The expected components in CMMI are the specific and generic practices.

Before goals can be considered satisfied, either the practices as described or acceptable alternatives to them must be present in the planned and implemented processes of the organization.

Informative Components

Informative components provide details that help organizations understand the required and expected components. Subpractices, typical work products, goal and practice titles, goal and practice notes, examples, and references are examples of informative model components.

For CMMI-ACQ, typical supplier deliverables are added informative components due to the interaction between supplier and acquirer processes.

The CMMI glossary of terms is not a required, expected, or informative component of CMMI models. You should interpret the terms in the glossary in the context of the model component in which they appear.

Components Associated with Part Two

The model components associated with Part Two can be summarized to illustrate their relationships, as shown in Figure 2.1.

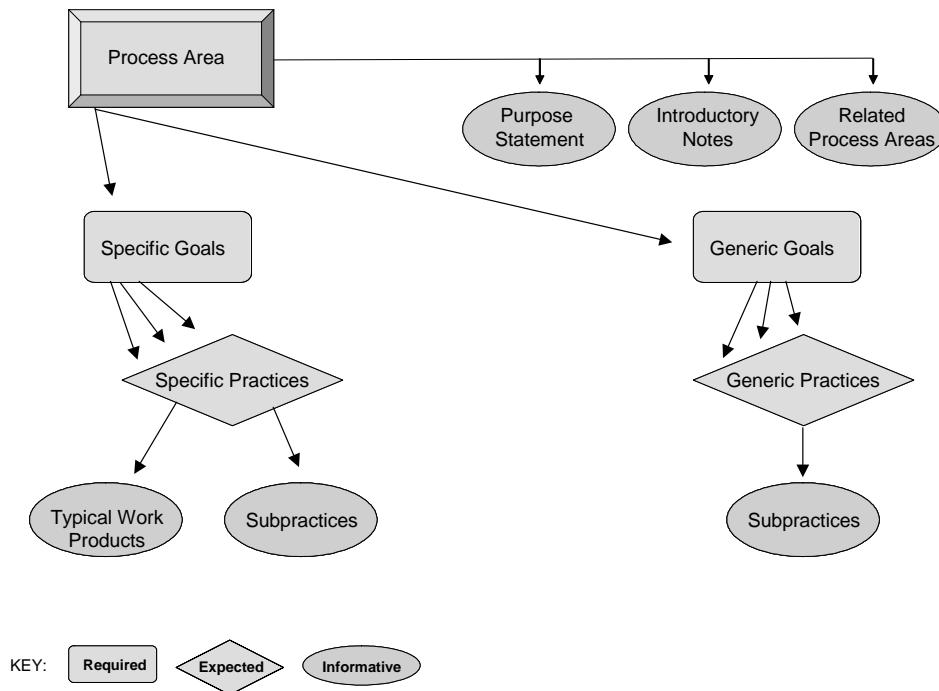


Figure 2.1: CMMI Model Components

The following sections provide detailed descriptions of CMMI model components.

Process Areas

A process area is a cluster of related practices in an area that, when implemented collectively, satisfies a set of goals considered important for making improvement in that area.

There are twenty-two process areas, presented in alphabetical order by acronym:

- Agreement Management (AM)
- Acquisition Requirements Development (ARD)
- Acquisition Technical Management (ATM)
- Acquisition Validation (AVAL)
- Acquisition Verification (AVER)
- Causal Analysis and Resolution (CAR)
- Configuration Management (CM)
- Decision Analysis and Resolution (DAR)
- Integrated Project Management (IPM)
- Measurement and Analysis (MA)
- Organizational Innovation and Deployment (OID)
- Organizational Process Definition (OPD)
- Organizational Process Focus (OPF)
- Organizational Process Performance (OPP)
- Organizational Training (OT)
- Project Monitoring and Control (PMC)
- Project Planning (PP)
- Process and Product Quality Assurance (PPQA)
- Quantitative Project Management (QPM)
- Requirements Management (REQM)
- Risk Management (RSKM)
- Solicitation and Supplier Agreement Development (SSAD)

Purpose Statements

A purpose statement describes the purpose of the process area and is an informative component.

For example, the purpose statement of the Organizational Process Definition process area is “The purpose of Organizational Process Definition (OPD) is to establish and maintain a usable set of organizational process assets and work environment standards.”

Introductory Notes

The introductory notes section of the process area describes the major concepts covered in the process area and is an informative component.

An example from the introductory notes of the Project Planning process area is “Planning begins with requirements that define the product and project.”

Related Process Areas

The related process areas section lists references to related process areas and reflects the high-level relationships among the process areas. The related process area section is an informative component.

An example of a reference found in the related process areas section of the Project Planning process area is “Refer to the Risk Management process area for more information about identifying and managing risks.”

Specific Goals

A specific goal describes the unique characteristics that must be present to satisfy the process area. A specific goal is a required model component and is used in appraisals to help determine whether a process area is satisfied.

For example, a specific goal from the Configuration Management process area is “Integrity of baselines is established and maintained.”

Only the statement of the specific goal is a required model component. The title of a specific goal (preceded by the goal number) and notes associated with the goal are considered informative model components.

Generic Goals

Generic goals are called *generic* because the same goal statement applies to multiple process areas. A generic goal describes the characteristics that must be present to institutionalize the processes that implement a process area. A generic goal is a required model component and is used in appraisals to determine whether a process area is satisfied. (See the “Generic Goals and Generic Practices” section in Part Two for a more detailed description of generic goals.)

An example of a generic goal is “The process is institutionalized as a defined process.”

Only the statement of the generic goal is a required model component. The title of a generic goal (preceded by the goal number) and notes associated with the goal are considered informative model components.

Specific Goal and Practice Summaries

The specific goal and practice summary provides a high-level summary of the specific goals, which are required components, and the specific practices, which are expected components. The specific goal and practice summary is an informative component.

Specific Practices

A specific practice is the description of an activity that is considered important in achieving the associated specific goal. The specific practices describe the activities that are expected to result in achievement of the specific goals of a process area. A specific practice is an expected model component.

For example, a specific practice from the Project Monitoring and Control process area is “Monitor commitments against those identified in the project plan.”

Only the statement of the specific practice is an expected model component. The title of a specific practice (preceded by the practice number) and notes associated with the specific practice are considered informative model components.

Typical Work Products

The typical work products section lists sample output from a specific practice. These examples are called typical work products because there are often other work products that are just as effective but are not listed. A typical work product is an informative model component.

For example, a typical work product for the specific practice “Monitor actual values of project planning parameters against the project plan” in the Project Monitoring and Control process area is “Records of significant deviations.”

Typical Supplier Deliverables

To aid the acquirer, typical supplier deliverables are also provided. A typical supplier deliverable represents an artifact that is input into or supports the acquirer’s implementation of the practice.

For example, a typical supplier deliverable for the specific practice “Perform activities with the supplier as specified in the supplier agreement” in the Agreement Management process area is “Supplier project progress and performance reports.”

Subpractices

A subpractice is a detailed description that provides guidance for interpreting and implementing a specific or generic practice. Subpractices may be worded as if prescriptive, but they are actually an informative component meant only to provide ideas that may be useful for process improvement.

For example, a subpractice for the specific practice “Take corrective action on identified issues” in the Project Monitoring and Control process area is “Determine and document the appropriate actions needed to address identified issues.”

Generic Practices

Generic practices are called *generic* because the same practice applies to multiple process areas. A generic practice is the description of an activity that is considered important in achieving the associated generic goal. A generic practice is an expected model component.

For example, a generic practice for the generic goal “The process is institutionalized as a managed process” is “Provide adequate resources for performing the process, developing the work products, and providing the services of the process.”

Only the statement of the generic practice is an expected model component. The title of a generic practice (preceded by the practice number) and notes associated with the practice are considered informative model components.

Supporting Informative Components

There are many places in the model where further information is needed to describe a concept. This informative material is provided in the form of the following components:

- Notes
- Examples
- References

Notes

A note is text that can accompany nearly any other model component. It may provide detail, background, or rationale. A note is an informative model component.

For example, a note that accompanies the specific practice “Implement selected action proposals developed in causal analysis” in the Causal Analysis and Resolution process area is “Only changes that prove to be of value should be considered for broad implementation.”

Examples

An example is a component comprising text and often a list of items, usually in a box, that can accompany nearly any other component and provides one or more examples to clarify a concept or described activity. An example is an informative model component.

The following is an example that accompanies the subpractice “Document noncompliance issues when they cannot be resolved in the project” under the specific practice “Communicate quality issues and ensure the resolution of noncompliance issues with the staff and managers” in the Process and Product Quality Assurance process area.

Examples of ways to resolve noncompliance in the project include the following:

- Fixing the noncompliance
- Changing the process descriptions, standards, or procedures that were violated
- Obtaining a waiver to cover the noncompliance

References

A reference is a pointer to additional or more detailed information in related process areas and can accompany nearly any other model component. A reference is an informative model component.

For example, a reference that accompanies the specific practice “Select subprocesses that compose the project’s defined process based on historical stability and capability data” in the Quantitative Project Management process area is “Refer to the Organizational Process Definition process area for more information about the organization’s process asset library, which might include a process element of known and needed capability.”

Numbering Scheme

Specific and generic goals are numbered sequentially. Each specific goal begins with the prefix SG (e.g., SG 1). Each generic goal begins with the prefix GG (e.g., GG 2).

Specific and generic practices also are numbered sequentially. Each specific practice begins with the prefix SP, followed by a number in the form x.y (e.g., SP 1.1). The x is the same number as the goal to which the specific practice maps. The y is the sequence number of the specific practice under the specific goal.

An example of specific practice numbering is in the Project Planning process area. The first specific practice is numbered SP 1.1 and the second is SP 1.2.

Each generic practice begins with the prefix GP, followed by a number in the form x.y (e.g., GP 1.1).

The x corresponds to the number of the generic goal. The y is the sequence number of the generic practice under the generic goal. For example, the first generic practice associated with GG 2 is numbered GP 2.1 and the second is GP 2.2.

Typographical Conventions

The typographical conventions used in this model were designed to enable you to select what you need and use it effectively. We present model components in formats that allow you to find them quickly on the page.

Figures 2.2 through 2.3 are sample pages from process areas in Part Two; they show the different process area components, labeled so that you can identify them. Notice that components differ typographically so that you can easily identify each one.

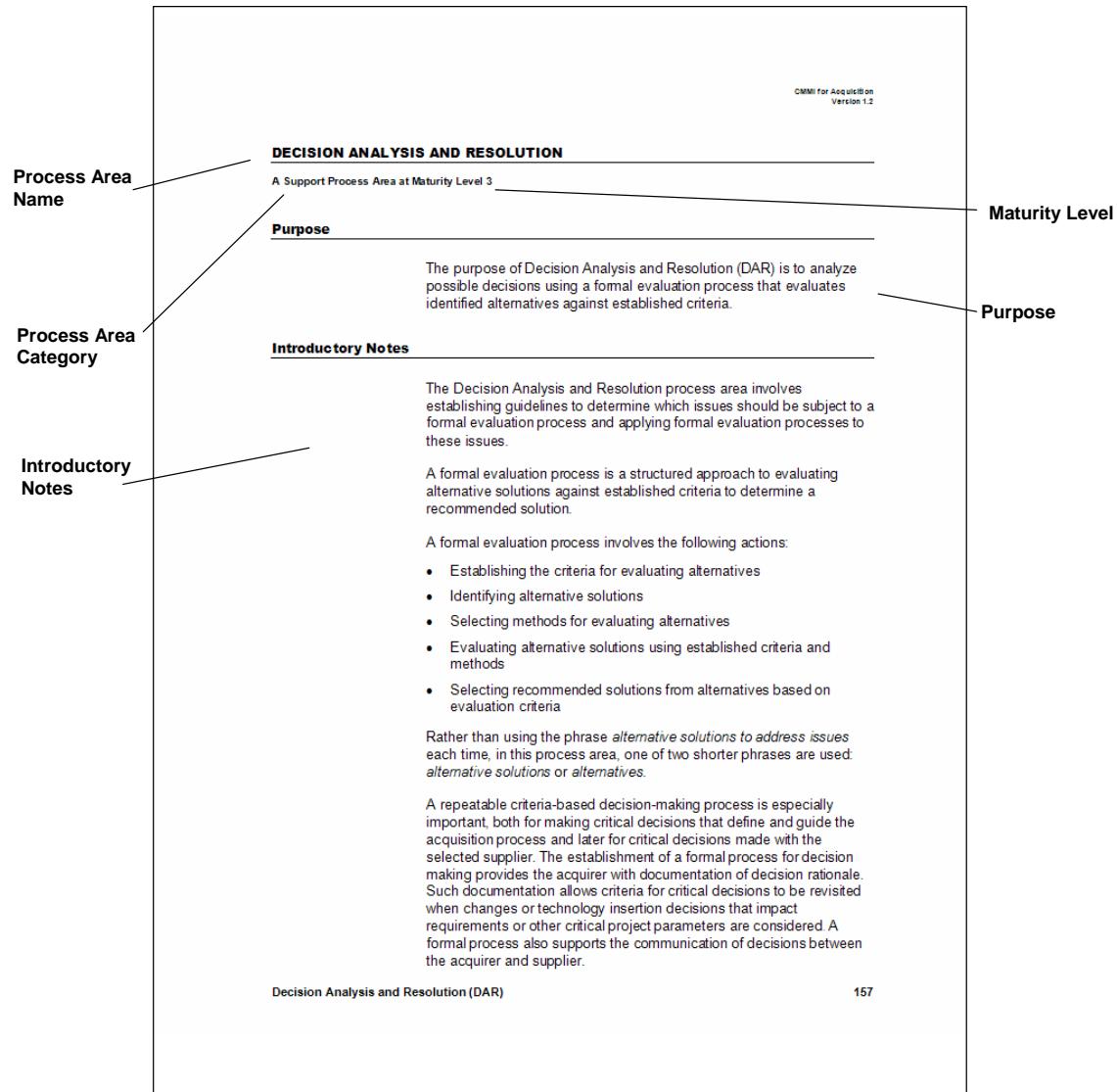


Figure 2.2: Sample Page from Decision Analysis and Resolution

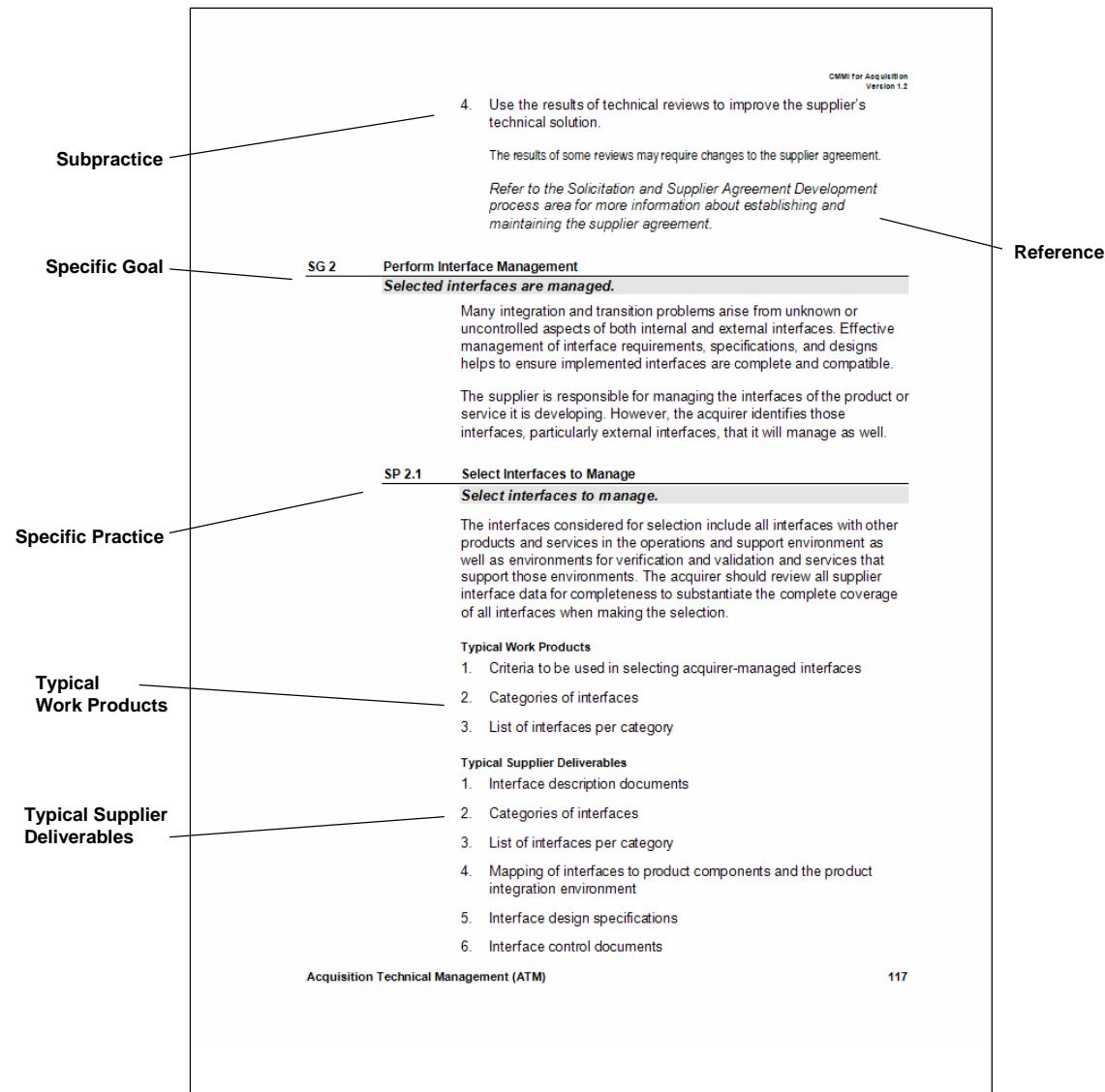


Figure 2.3: Sample Page from Acquisition Technical Management

3 Tying It All Together

Now that you have been introduced to the components of CMMI models, you need to understand how they fit together to meet your process improvement needs. This chapter introduces the concept of *levels* and shows how the process areas are organized and used.

CMMI-ACQ does not specify that a project or organization must follow a particular acquisition process flow or that a certain number of deliverables per day or specific performance targets be achieved—only that they have processes in place for adequately addressing acquisition-related practices. To determine whether this is so, a project or organization maps its processes to the process areas contained in this document.

The mapping of processes to process areas enables acquirers to track their progress against the CMMI-ACQ model as they implement processes. It is not intended that every process area of the CMMI-ACQ will map one to one with a given organization's or project's processes.

Understanding Levels

Levels are used in CMMI to describe an evolutionary path recommended for an organization that wants to improve the processes it uses to acquire capabilities, including products and services. Levels can also be the outcome of the rating activity in appraisals.⁶ Appraisals can apply to entire companies or to smaller groups such as a small group of projects or a division in a company.

CMMI supports two improvement paths using levels. One path enables organizations to incrementally improve processes corresponding to an individual process area (or process areas) selected by the organization. The other path enables organizations to improve a set of related processes by incrementally addressing successive sets of process areas.

⁶ For more information about appraisals, refer to *Appraisal Requirements for CMMI* and the *Standard CMMI Appraisal Method for Process Improvement Method Definition Document* [SEI 2006c, SEI 2006b].

These two improvement paths are associated with the two types of levels, capability levels and maturity levels. These levels correspond to two approaches to process improvement called *representations*. The two representations are *continuous* and *staged*. The continuous representation has *capability levels*. The staged representation has *maturity levels*.

Regardless of which representation you select, the *level* concept is the same. Levels characterize improvement from an ill-defined state to a state that uses quantitative information to determine and manage improvements that are needed to meet an organization's business objectives.

To reach a particular level, an organization must satisfy all of the appropriate goals of the process area or set of process areas that are targeted for improvement, regardless of whether it is a capability or a maturity level.

Both representations provide ways to implement process improvement to achieve business objectives, and both provide the same essential content and use the same model components.

Structures of the Continuous and Staged Representations

Figure 3.1 illustrates the structures of the continuous and staged representations. The differences jump out at you immediately when you look at these structures. The staged representation utilizes maturity levels, whereas the continuous representation utilizes capability levels.

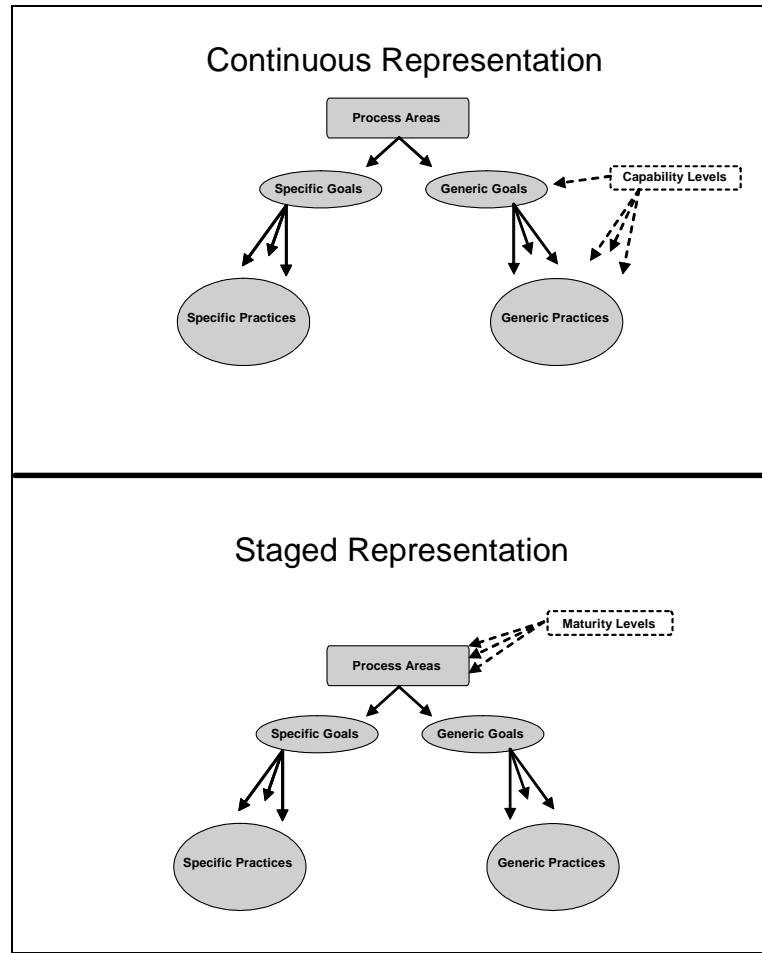


Figure 3.1: Structure of the Continuous and Staged Representations

What may strike you as you compare these two representations is their similarity. Both have many of the same components (e.g., process areas, specific goals, and specific practices), and these components have the same hierarchy and configuration.

What is not readily apparent from the high-level view in Figure 3.1 is that the continuous representation focuses on process area capability as measured by capability levels and the staged representation focuses on organizational maturity as measured by maturity levels. These dimensions (the capability/maturity dimensions) of CMMI are used for benchmarking and appraisal activities, as well as guiding an organization's improvement efforts.

- Capability levels apply to an organization's process improvement achievement in individual process areas. These levels are a means for incrementally improving the processes corresponding to a given process area. There are six capability levels, which are numbered 0 through 5.

- Maturity levels apply to an organization's process improvement achievement across multiple process areas. These levels are a means of predicting the general outcomes of the next project undertaken. There are five maturity levels, numbered 1 through 5.

Table 3.1 compares the six capability levels to the five maturity levels. Notice that the names of four of the levels are the same in both representations. The differences are that there is no maturity level 0 and at level 1, the capability level is *Performed*, whereas the maturity level is *Initial*. Therefore, the starting point is different.

Table 3.1 Comparison of Capability and Maturity Levels

Level	Continuous Representation Capability Levels	Staged Representation Maturity Levels
Level 0	Incomplete	(not applicable)
Level 1	Performed	Initial
Level 2	Managed	Managed
Level 3	Defined	Defined
Level 4	Quantitatively Managed	Quantitatively Managed
Level 5	Optimizing	Optimizing

The continuous representation is concerned with selecting both a particular process area to improve and the desired capability level for that process area. In this context, whether a process is performed or incomplete is important. Therefore, the name *incomplete* is given to the continuous representation starting point.

Because the staged representation is concerned with the overall maturity of the organization, whether individual processes are performed or incomplete is not the primary focus. Therefore, the name *initial* is given to the staged representation starting point.

Both capability levels and maturity levels provide a way to measure how well organizations can and do improve their processes. However, the associated approach to process improvement is different.

Understanding Capability Levels

To support those using the continuous representation, all CMMI models reflect capability levels in their design and content.

The six capability levels, designated by the numbers 0 through 5, are as follows:

0. Incomplete
1. Performed
2. Managed
3. Defined
4. Quantitatively Managed
5. Optimizing

A capability level for a process area is achieved when all of the generic goals are satisfied up to that level. The fact that capability levels 2 through 5 use the same terms as generic goals 2 through 5 is intentional because each of these generic goals and practices reflects the meaning of the capability levels of the goals and practices. (See the “Generic Goals and Generic Practices” section in Part Two for more information about generic goals and practices.) A short description of each capability level follows.

Capability Level 0: Incomplete

An *incomplete* process is a process that either is not performed or partially performed. One or more of the specific goals of the process area are not satisfied, and no generic goals exist for this level since there is no reason to institutionalize a partially performed process.

Capability Level 1: Performed

A capability level 1 process is characterized as a *performed process*. A performed process is a process that satisfies the specific goals of the process area. It supports and enables the work needed to acquire capabilities.

Although capability level 1 results in important improvements, those improvements can be lost over time if they are not institutionalized. The application of institutionalization (the CMMI generic practices at capability levels 2 through 5) helps to ensure that improvements are maintained.

Capability Level 2: Managed

A capability level 2 process is characterized as a *managed process*. A managed process is a performed (capability level 1) process that has the basic infrastructure in place to support the process. It is planned and executed in accordance with policy; employs skilled people who have adequate resources to produce controlled outputs; involves relevant stakeholders; is monitored, controlled, and reviewed; and is evaluated for adherence to its process description. The process discipline reflected by capability level 2 helps to ensure that existing practices are retained during times of stress.

Capability Level 3: Defined

A capability level 3 process is characterized as a *defined process*. A defined process is a managed (capability level 2) process that is tailored from the organization's set of standard processes according to the organization's tailoring guidelines and contributes work products, measures, and other process improvement information to the organizational process assets.

A critical distinction between capability levels 2 and 3 is the scope of standards, process descriptions, and procedures. At capability level 2, the standards, process descriptions, and procedures may be quite different in each specific instance of the process (e.g., on a particular project). At capability level 3, the standards, process descriptions, and procedures for a project are tailored from the organization's set of standard processes to suit a particular project or organizational unit and therefore are more consistent, except for the differences allowed by the tailoring guidelines.

Another critical distinction is that at capability level 3, processes are typically described more rigorously than at capability level 2. A defined process clearly states the purpose, inputs, entry criteria, activities, roles, measures, verification steps, outputs, and exit criteria. At capability level 3, processes are managed more proactively using an understanding of the interrelationships of the process activities and detailed measures of the process, its work products, and its services.

Capability Level 4: Quantitatively Managed

A capability level 4 process is characterized as a *quantitatively managed process*. A quantitatively managed process is a defined (capability level 3) process that is controlled using statistical and other quantitative techniques. Quantitative objectives for quality and process performance are established and used as criteria in managing the process. Quality and process performance is understood in statistical terms and is managed throughout the life of the process.

Capability Level 5: Optimizing

A capability level 5 process is characterized as an *optimizing process*. An optimizing process is a quantitatively managed (capability level 4) process that is improved based on an understanding of the common causes of variation inherent in the process. The focus of an optimizing process is on continually improving the range of process performance through both incremental and innovative improvements.

Remember that capability levels 2 through 5 use the same terms as generic goals 2 through 5, and a detailed description of these terms appears in the “Generic Goals and Generic Practices” section in Part Two.

Advancing Through Capability Levels

The capability levels of a process area are achieved through the application of generic practices or suitable alternatives to the processes associated with that process area.

Reaching capability level 1 for a process area is equivalent to saying that the processes associated with that process area are *performed processes*.

Reaching capability level 2 for a process area is equivalent to saying that there is a policy that indicates you will perform the process. There is a plan for performing it, resources are provided, responsibilities are assigned, training to perform it is provided, selected work products related to performing the process are controlled, and so on. In other words, a capability level 2 process can be planned and monitored just like any project or support activity.

Reaching capability level 3 for a process area assumes that an organizational standard process exists associated with that process area, which can be tailored to the needs of the project. The processes in the organization are now more consistently defined and applied because they are based on organizational standard processes.

Reaching capability level 4 for a process area assumes that this process area is a key business driver that the organization wants to manage using quantitative and statistical techniques. This analysis gives the organization more visibility into the performance of selected subprocesses, which will make it more competitive in the marketplace.

Reaching capability level 5 for a process area assumes that you have stabilized the selected subprocesses and that you want to reduce the common causes of variation in that process. Remember that variation is a natural occurrence in any process, so although it is conceptually feasible to improve all processes, it is not economical to improve all processes to level 5. Again, you want to concentrate on those processes that help you to meet your business objectives.

Understanding Maturity Levels

To support those using the staged representation, all CMMI models reflect maturity levels in their design and content. A maturity level consists of related specific and generic practices for a predefined set of process areas that improve the organization's overall performance. The maturity level of an organization provides a way to predict an organization's performance in a given discipline or set of disciplines. Experience has shown that organizations do their best when they focus their process improvement efforts on a manageable number of process areas at a time and that those areas require increasing sophistication as the organization improves.

A maturity level is a defined evolutionary plateau for organizational process improvement. Each maturity level matures an important subset of the organization's processes, preparing it to move to the next maturity level. The maturity levels are measured by the achievement of the specific and generic goals associated with each predefined set of process areas.

There are five maturity levels, each a layer in the foundation for ongoing process improvement, designated by the numbers 1 through 5:

1. Initial
2. Managed
3. Defined
4. Quantitatively Managed
5. Optimizing

Remember that maturity levels 2 through 5 use the same terms as capability levels 2 through 5. This was intentional because the concepts of maturity levels and capability levels are complementary. Maturity levels are used to characterize organizational improvement relative to a set of process areas, and capability levels characterize organizational improvement relative to an individual process area.

Maturity Level 1: Initial

At maturity level 1, processes are usually ad hoc and chaotic. The organization usually does not provide a stable environment to support processes. Success in these organizations depends on the competence and heroics of the people in the organization and not on the use of proven processes. In spite of this chaos, maturity level 1 organizations acquire products and services that often work, but they frequently exceed the budget and schedule documented in their plans.

Maturity level 1 organizations are characterized by a tendency to overcommit, abandonment of processes in a time of crisis, and an inability to repeat their successes.

Maturity Level 2: Managed

At maturity level 2, projects establish the foundation for an organization to become an effective acquirer of needed capabilities by institutionalizing basic project management and supplier management practices. Projects define a supplier strategy, create project plans, and monitor and control the project to ensure the product or service is delivered as planned. The acquirer establishes an agreement with suppliers supporting the projects and manages such agreements to ensure each supplier delivers on commitments. The acquirer develops and manages customer and contractual requirements. Configuration management and process and product quality assurance are institutionalized, and the acquirer also develops the capability to measure and analyze process performance.

At maturity level 2, projects, processes, work products, and services are managed. The acquirer ensures that processes are planned in accordance with policy. In order to execute the process, the acquirer provides adequate resources, assigns responsibility for performing the process, trains people on the process, and ensures the designated work products of the process are under appropriate levels of configuration management. The acquirer identifies and involves appropriate stakeholders and periodically monitors and controls the process. Process adherence is periodically evaluated and process performance is shared with senior management. The process discipline reflected by maturity level 2 helps to ensure that existing practices are retained during times of stress.

Maturity Level 3: Defined

At maturity level 3, acquirers use defined processes for managing projects and suppliers. They embed tenets of project management and acquisition best practices, such as integrated project management and acquisition technical management, into the standard process set. The acquirer verifies that selected work products meet their requirements and validates products and services to ensure they fulfill their intended use in the intended environment. These processes are well characterized and understood and are described in standards, procedures, tools, and methods.

The organization's set of standard processes, which is the basis for maturity level 3, is established and improved over time. These standard processes are used to establish consistency across the organization. Projects establish their defined processes by tailoring the organization's set of standard processes according to tailoring guidelines. (See the glossary for a definition of "organization's set of standard processes.")

A critical distinction between maturity levels 2 and 3 is the scope of standards, process descriptions, and procedures. At maturity level 2, the standards, process descriptions, and procedures may be quite different in each specific instance of the process (e.g., on a particular project). At maturity level 3, the standards, process descriptions, and procedures for a project are tailored from the organization's set of standard processes to suit a particular project or organizational unit and therefore are more consistent except for the differences allowed by the tailoring guidelines.

Another critical distinction is that at maturity level 3, processes are typically described more rigorously than at maturity level 2. A defined process clearly states the purpose, inputs, entry criteria, activities, roles, measures, verification steps, outputs, and exit criteria. At maturity level 3, processes are managed more proactively using an understanding of the interrelationships of process activities and detailed measures of the process, its work products, and its services.

At maturity level 3, the organization must further mature the maturity level 2 process areas. Generic practices associated with generic goal 3 that were not addressed at maturity level 2 are applied to achieve maturity level 3.

Due to the acquirer-supplier relationship, the need for early and aggressive detection of risk is compounded by the complexity of projects acquiring products and services. The purpose of risk management is to identify and assess project risks during project planning and manage these risks throughout the project.

Maturity Level 4: Quantitatively Managed

At maturity level 4, acquirers establish quantitative objectives for quality and process performance and use them as criteria in managing processes. Quantitative objectives are based on needs of the customer, end users, organization, and process implementers. Quality and process performance is understood in statistical terms and is managed throughout the life of processes.

For selected subprocesses, specific measures of process performance are collected and statistically analyzed. When selecting processes or subprocesses for analyses, it is critical to understand the relationships between different processes and subprocesses and their impact on the acquirer's and supplier's performance relative to delivering the product specified by the customer. Such an approach helps to ensure that quantitative and statistical management is applied to where it has the most overall value to the business. Supplier process performance is analyzed as it interfaces with acquirer processes, through data and measures submitted by the supplier. Performance models are used to set performance objectives for both acquirer and supplier performance and to help both parties achieve their objectives.

A critical distinction between maturity levels 3 and 4 is the predictability of process performance. At maturity level 4, the performance of processes is controlled using statistical and other quantitative techniques and is quantitatively predictable. At maturity level 3, processes are typically only qualitatively predictable.

Maturity Level 5: Optimizing

At maturity level 5, an organization continually improves its processes based on a quantitative understanding of the common causes of variation inherent in processes. (See the definition of "common cause of process variation" in the glossary.)

Maturity level 5 focuses on continually improving process performance through incremental and innovative process and technology improvements that enhance the acquirer's and its suppliers' ability to meet the acquirer's quality and process-performance objectives.

Quantitative process improvement objectives for the organization are established, continually revised to reflect changing business objectives, and used as criteria in managing process improvement. The effects of deployed process improvements are measured and compared to quantitative process improvement objectives. Both the defined processes and the organization's set of standard processes are targets of measurable improvement activities.

The acquirer typically achieves its quality and performance objectives through coordination with its suppliers. The acquirer typically focuses on capability differentiation and collaborative supplier management. Achievement of these objectives also depends on being able to effectively evaluate and deploy proposed improvements to processes and technologies. For best results, members of the acquirer-supplier network participate in the acquirer's process- and technology-improvement activities. Process improvement proposals are systematically gathered and addressed.

A critical distinction between maturity levels 4 and 5 is the type of process variation addressed. At maturity level 4, the organization is concerned with addressing special causes of process variation and providing statistical predictability of results. Although processes may produce predictable results, the results may be insufficient to achieve established objectives. At maturity level 5, the organization is concerned with addressing common causes of process variation and changing the process (to shift the mean of the process performance or reduce the inherent process variation experienced) to improve process performance and to achieve established quantitative process improvement objectives.

Advancing Through Maturity Levels

Organizations can achieve progressive improvements in their organizational maturity by achieving control first at the project level and continuing to the most advanced level—organization-wide continuous process improvement—using both quantitative and qualitative data to make decisions.

Since improved organizational maturity is associated with improvement in the range of expected results that can be achieved by an organization, it is one way of predicting general outcomes of the organization's next project. For instance, at maturity level 2, the organization has been elevated from ad hoc to disciplined by establishing sound project management. As your organization achieves generic and specific goals for the set of process areas in a maturity level, you are increasing your organizational maturity and reaping the benefits of process improvement. Because each maturity level forms a necessary foundation for the next level, trying to skip maturity levels is usually counterproductive.

At the same time, you must recognize that process improvement efforts should focus on the needs of the organization in the context of its business environment and that process areas at higher maturity levels address the current needs of an organization or project. For example, organizations seeking to move from maturity level 1 to maturity level 2 are frequently encouraged to establish a process group, which is addressed by the Organizational Process Focus process area that resides at maturity level 3. Although a process group is not a necessary characteristic of a maturity level 2 organization, it can be a useful part of the organization's approach to achieving maturity level 2.

This situation is sometimes characterized as establishing a maturity level 1 process group to bootstrap the maturity level 1 organization to maturity level 2. Maturity level 1 process improvement activities may depend primarily on the insight and competence of the process group staff until an infrastructure to support more disciplined and widespread improvement is in place.

Organizations can institute process improvements anytime they choose, even before they are prepared to advance to the maturity level at which the specific practice is recommended. In such situations, however, organizations should understand that the success of these improvements is at risk because the foundation for their successful institutionalization has not been completed. Processes without the proper foundation may fail at the point they are needed most—under stress.

A defined process that is characteristic of a maturity level 3 organization can be placed at great risk if maturity level 2 management practices are deficient. For example, management may commit to a poorly planned schedule or fail to control changes to baselined requirements. Similarly, many organizations prematurely collect the detailed data characteristic of maturity level 4 only to find the data uninterpretable because of inconsistencies in processes and measurement definitions.

Process Areas

Process areas are viewed differently in the two representations. Figure 3.2 compares views of how process areas are used in the continuous representation and the staged representation.

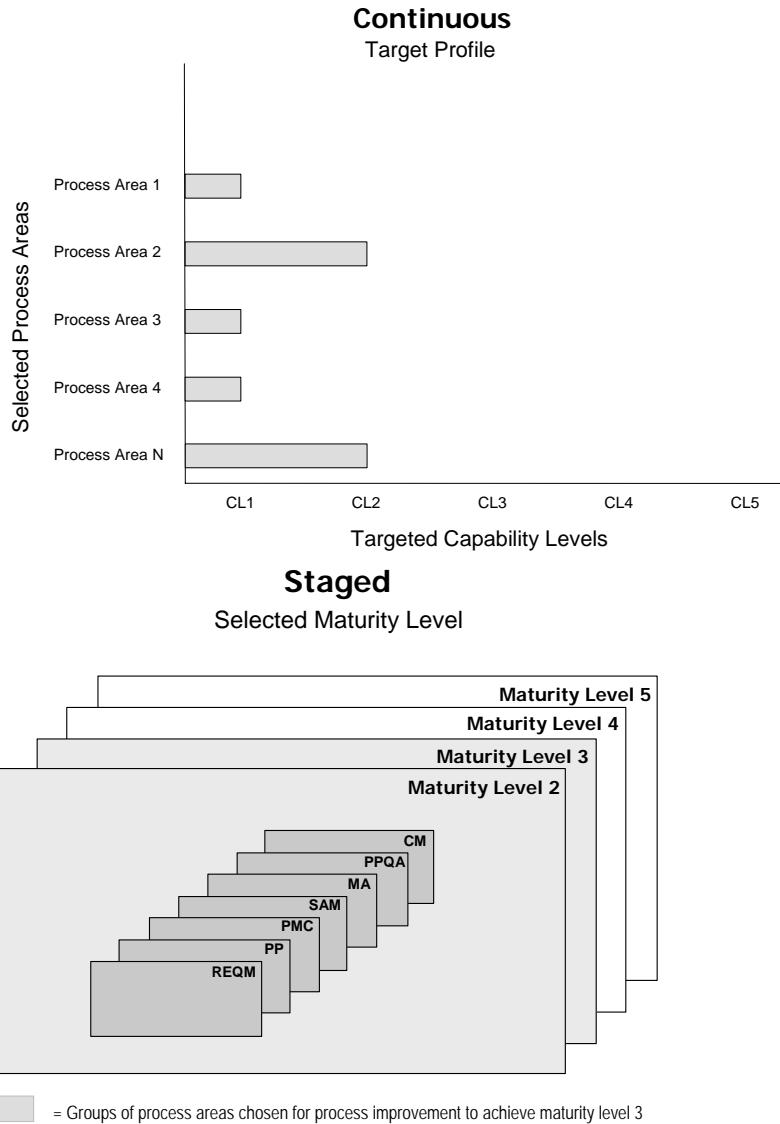


Figure 3.2: Process Areas in Continuous and Staged Representations

The continuous representation enables the organization to choose the focus of its process improvement efforts by choosing those process areas, or sets of interrelated process areas, that best benefit the organization and its business objectives. Although there are some limits on what an organization can choose because of the dependencies among process areas, the organization has considerable freedom in its selection.

To support those using the continuous representation, process areas are organized into four categories: Process Management, Project Management, Acquisition, and Support. These categories emphasize some of the key relationships that exist among the process areas.

Once you select process areas, you must also select how much you would like to mature processes associated with those process areas (i.e., select the appropriate capability level). Capability levels and generic goals and practices support the improvement of processes associated with individual process areas. For example, an organization may wish to reach capability level 2 in one process area and capability level 4 in another. As the organization reaches a capability level, it sets its sights on the next capability level for one of these same process areas or decides to widen its view and address a larger number of process areas.

This selection of a combination of process areas and capability levels is typically described in a target profile. A target profile defines all of the process areas to be addressed and the targeted capability level for each. This profile governs which goals and practices the organization will address in its process improvement efforts.

Most organizations, at minimum, target capability level 1, which requires that all specific goals of the process area be achieved. However, organizations that target capability levels higher than 1 concentrate on the institutionalization of selected processes in the organization by implementing the associated generic goals and practices.

The staged representation provides a predetermined path of improvement from maturity level 1 to maturity level 5 that involves achieving the goals of the process areas at each maturity level. To support those using the staged representation, process areas are grouped by maturity level, indicating which process areas to implement to achieve each maturity level. For example, at maturity level 2, there is a set of process areas that an organization would use to guide its process improvement until it could achieve all the goals of all these process areas. Once maturity level 2 is achieved, the organization focuses its efforts on maturity level 3 process areas, and so on. The generic goals that apply to each process area are also predetermined. Generic goal 2 applies to maturity level 2 and generic goal 3 applies to maturity levels 3 through 5.

Table 3.2 provides a list of CMMI-ACQ process areas and their associated categories and maturity levels.

Table 3.2 Process Areas and Their Associated Categories and Maturity Levels

Process Area	Category	Maturity Level
Agreement Management (AM)	Acquisition	2
Acquisition Requirements Development (ARD)	Acquisition	2
Acquisition Technical Management (ATM)	Acquisition	3
Acquisition Validation (AVAL)	Acquisition	3
Acquisition Verification (AVER)	Acquisition	3
Causal Analysis and Resolution (CAR)	Support	5
Configuration Management (CM)	Support	2
Decision Analysis and Resolution (DAR)	Support	3
Integrated Project Management (IPM)	Project Management	3
Measurement and Analysis (MA)	Support	2
Organizational Innovation and Deployment (OID)	Process Management	5
Organizational Process Definition (OPD)	Process Management	3
Organizational Process Focus (OPF)	Process Management	3
Organizational Process Performance (OPP)	Process Management	4
Organizational Training (OT)	Process Management	3
Project Monitoring and Control (PMC)	Project Management	2
Project Planning (PP)	Project Management	2
Process and Product Quality Assurance (PPQA)	Support	2
Quantitative Project Management (QPM)	Project Management	4
Requirements Management (REQM)	Project Management	2
Risk Management (RSKM)	Project Management	3
Solicitation and Supplier Agreement Development (SSAD)	Acquisition	2

Equivalent Staging

Equivalent staging is a way to compare results from using the continuous representation to those of the staged representation. In essence, if you measured improvement relative to selected process areas using capability levels in the continuous representation, how would you compare that to maturity levels? Is this possible?

Up to this point, we have not discussed process appraisals in much detail. The SCAMPISM method⁷ is used to appraise organizations using CMMI, and one result of an appraisal is a rating [SEI 2006b, Ahern 2005]. If the continuous representation is used for an appraisal, the rating is a capability level profile. If the staged representation is used for an appraisal, the rating is a maturity level (e.g., maturity level 3) rating.

A capability level profile is a list of process areas and the corresponding capability level achieved for each. This profile enables an organization to track its capability level by process area. The profile is an *achievement profile* when it represents the organization's actual progress for each process area. Alternatively, the profile is a *target profile* when it represents the organization's planned process improvement objectives. Figure 3.3 illustrates a combined target and achievement profile. The gray portion of each bar represents what has been achieved. The unshaded portion represents what remains to be accomplished to meet the target profile.

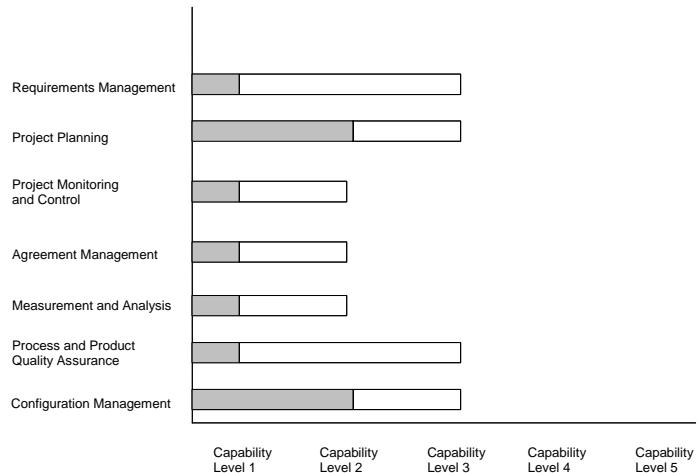


Figure 3.3: An Example of a Target and Achievement Profile

An achievement profile, when compared with a target profile, enables an organization to plan and track its progress for each selected process area. Maintaining capability level profiles is advisable when using the continuous representation.

⁷ The Standard CMMI Appraisal Method for Process Improvement (SCAMPI) method is described in Chapter 5.

Target staging is a sequence of target profiles that describes the path of process improvement to be followed by the organization. When building target profiles, the organization should pay attention to the dependencies between generic practices and process areas. If a generic practice depends on a process area, either to carry out the generic practice or to provide a prerequisite product, the generic practice may be much less effective when the process area is not implemented.⁸

Although there are many reasons to use the continuous representation, ratings consisting of capability level profiles are limited in their ability to provide organizations with a way to generally compare themselves with other organizations. Capability level profiles could be used if each organization selected the same process areas; however, maturity levels have been used to compare organizations for years and already provide predefined sets of process areas.

Because of this situation, equivalent staging was created. Equivalent staging enables an organization using the continuous representation for an appraisal to convert a capability level profile to the associated maturity level rating.

The most effective way to depict equivalent staging is to provide a sequence of target profiles, each of which is equivalent to a maturity level rating of the staged representation. The result is a target staging that is equivalent to the maturity levels of the staged representation.

⁸ See Table 6.2 in the *Generic Goals and Generic Practices* section of Part Two for more information about the dependencies between generic practices and process areas.

Figure 3.4 shows a summary of the target profiles that must be achieved when using the continuous representation to be equivalent to maturity levels 2 through 5. Each shaded area in the capability level columns represents a target profile that is equivalent to a maturity level.

Name	Abbr.	ML	CL1	CL2	CL3	CL4	CL5
Agreement Management Acquisition Requirements Development Configuration Management Measurement and Analysis Project Monitoring and Control Project Planning Process and Product Quality Assurance Requirements Management Solicitation and Supplier Agreement Development	AM	2	Target Profile 2				
	ARD	2					
	CM	2					
	MA	2					
	PMC	2					
	PP	2					
	PPQA	2					
	REQM	2					
	SSAD	2					
Acquisition Technical Management Acquisition Validation Acquisition Verification Decision Analysis and Resolution Integrated Project Management Organizational Process Definition Organizational Process Focus Organizational Training Risk Management	ATM	3	Target Profile 3				
	AVAL	3					
	AVER	3					
	DAR	3					
	IPM	3					
	OPD	3					
	OPF	3					
	OT	3					
	RSKM	3					
Organizational Process Performance Quantitative Project Management	OPP	4	Target Profile 4				
	QPM	4					
Causal Analysis and Resolution Organizational Innovation and Deployment	CAR	5	Target Profile 5				
	OID	5					

Figure 3.4: Target Profiles and Equivalent Staging

The following rules summarize equivalent staging:

- To achieve maturity level 2, all process areas assigned to maturity level 2 must achieve capability level 2 or higher.
- To achieve maturity level 3, all process areas assigned to maturity levels 2 and 3 must achieve capability level 3 or higher.
- To achieve maturity level 4, all process areas assigned to maturity levels 2, 3, and 4 must achieve capability level 3 or higher.
- To achieve maturity level 5, all process areas must achieve capability level 3 or higher.

These rules and the table for equivalent staging are complete; however, you may ask why target profiles 4 and 5 do not extend into the CL4 and CL5 columns. The reason is that maturity level 4 process areas describe a selection of the subprocesses to be stabilized based, in part, on the quality and process-performance objectives of the organization and projects. Not every process area will be addressed in the selection and CMMI does not presume in advance which process areas might be addressed in the selection.

So, the achievement of capability level 4 for process areas cannot be predetermined because the choices depend on the selections made by the organization in its implementation of the maturity level 4 process areas. Thus, Figure 3.4 does not show target profile 4 extending into the CL4 column, although some process areas will have achieved capability level 4. The situation for maturity level 5 and target profile 5 is similar.

The existence of equivalent staging should not discourage users of the continuous representation from establishing target profiles that extend above capability level 3. Such a target profile would be determined in part by the selections made by the organization to meet its business objectives.

4 Relationships Among Process Areas

In this chapter we describe the key relationships among process areas to help you see the acquirer's view of process improvement and which process areas build on the implementation of other process areas.

The relationships among multiple process areas, including the information and artifacts that flow from one process area to another—illustrated by the figure and descriptions in this chapter—help you see a larger view of process implementation and improvement.

Successful process improvement initiatives must be driven by the business objectives of the organization. For example, a common business objective is to reduce the time it takes to get a product to market. The process improvement objective derived from that might be to improve the project management processes to ensure on-time delivery. Those improvements rely on best practices in the Project Planning and Project Monitoring and Control process areas.

Although we group process areas in this chapter to simplify the discussion of their relationships, process areas often interact and have an effect on one another regardless of their group, category, or level. For example, the Decision Analysis and Resolution process area (a Support process area at maturity level 3) contains specific practices that address the formal evaluation process used in the Solicitation and Supplier Agreement Development process area (an Acquisition process area at maturity level 2) to select suppliers for acquirer management.

Being aware of the key relationships that exist among CMMI process areas will help you apply CMMI in a useful and productive way. Relationships among process areas are described in more detail in the references in each process area and specifically in the *Related Process Areas* section of each process area in Part Two. Refer to Chapter 2 for more information about references.

Figure 4.1 illustrates key relationships among CMMI-ACQ process areas.

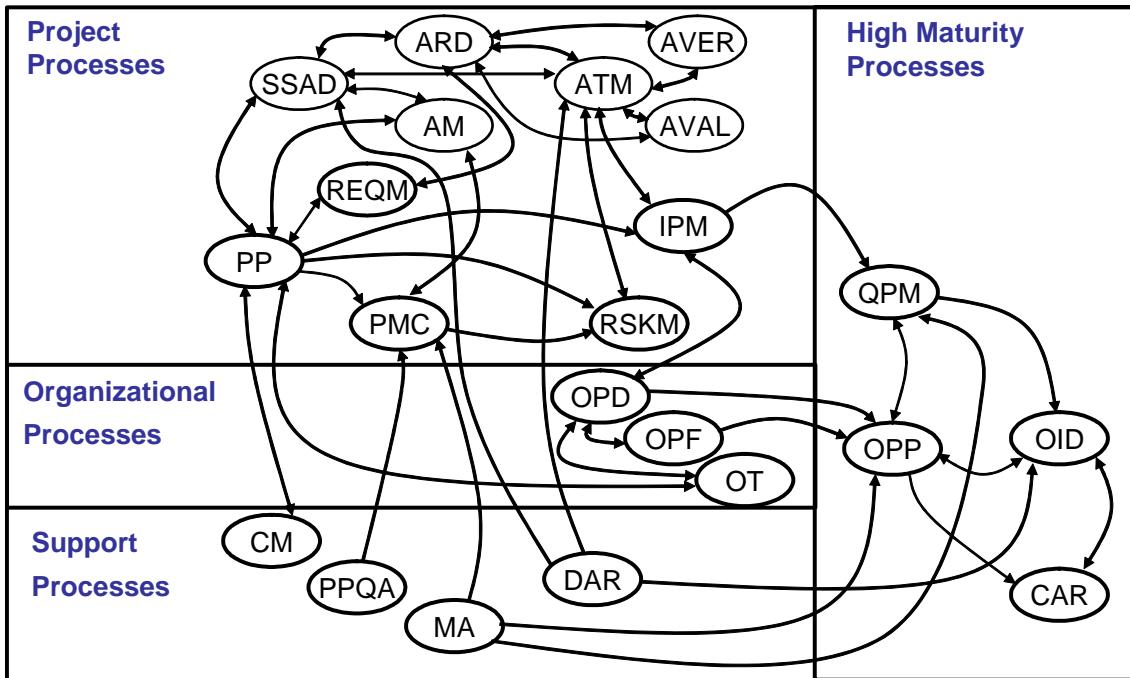


Figure 4.1 Key Relationships Among Process Areas

Project Processes

The project process areas contain practices that address acquirer activities related to establishing, executing, and transitioning an acquisition project.

The project process areas of CMMI-ACQ are as follows:

- Project Planning (PP)
- Acquisition Requirements Development (ARD)
- Requirements Management (REQM)
- Solicitation and Supplier Agreement Development (SSAD)
- Agreement Management (AM)
- Project Monitoring and Control (PMC)
- Integrated Project Management (IPM)
- Risk Management (RSKM)
- Acquisition Technical Management (ATM)
- Acquisition Verification (AVER)
- Acquisition Validation (AVAL)

The Project Planning process area includes practices for determining the acquisition strategy, developing the project plan, involving stakeholders appropriately, obtaining commitment to the plan, and maintaining the plan.

Planning begins with the acquisition strategy, which provides the framework for the acquisition project and its plans. The project plan covers the project management and acquisition activities performed by the project. Other plans (e.g., plans for transition to operations and support, configuration management, verification, and measurement and analysis) from relevant stakeholders that affect the project are reviewed, and commitments with those stakeholders for their contributions to the project are established.

Once the acquisition strategy is established using Project Planning practices, the strategy is used to focus on specifying customer and contractual requirements that express customer value in Acquisition Requirements Development practices. Customer needs are established and translated into customer requirements. The set of customer requirements is prioritized and a set of contractual requirements, including design constraints, is developed.

Development of contractual requirements and operational scenarios also depends on the acquisition strategy developed using Project Planning practices. This set of contractual requirements is used in Solicitation and Supplier Agreement Development practices to select suppliers and establish a supplier agreement to acquire the product or service. The product or service is designed and implemented by the supplier consistent with the acquirer's contractual requirements and design constraints.

Requirements are maintained using Requirements Management practices. These practices describe activities for obtaining and controlling requirement changes and ensuring that other relevant plans and data are kept current. They also describe the traceability of requirements from customer to contractual requirements and supplier agreements. Requirements Management practices interact with Acquisition Requirements Development practices. All changes to contractual requirements must be reflected in the supplier agreements established and maintained using Solicitation and Supplier Agreement Development practices.

The Solicitation and Supplier Agreement Development process area defines practices for preparing a solicitation package, selecting a capable supplier, and establishing and maintaining the supplier agreement. The acquisition strategy developed using Project Planning practices and contractual requirements developed using Acquisition Requirements Development practices are required to prepare for Solicitation and Supplier Agreement Development practices. An agreement is developed to acquire the product or service by identifying potential suppliers, developing the solicitation package, and distributing it to the potential suppliers. The acquirer evaluates the proposed solutions and negotiates with the supplier to finalize the agreement so that both the acquirer and supplier have a mutual understanding of the agreement. This agreement is established and maintained using Solicitation and Supplier Agreement Development, but the execution of the agreement is performed using Agreement Management practices.

The acquirer uses Agreement Management practices to manage the supplier agreement by performing the acquirer activities defined in the supplier agreement, monitoring selected supplier processes, accepting the product or service, and managing supplier invoices.

After a supplier is selected and a supplier agreement is established, the acquirer continues to apply Requirements Management practices to manage customer and contractual requirements, while the selected supplier is managing the refined product and product component requirements. Using Requirements Management practices ensures that changes to requirements are reflected in project plans, activities, and work products. This cycle of changes may affect or be affected by other processes; thus, the requirements management process is a dynamic and often recursive sequence of events.

The Project Monitoring and Control process area contains practices for monitoring and controlling acquirer activities and overseeing the supplier's progress and performance according to project plans. The process area includes coverage of monitoring and controlling the transition to operations and support that was planned using Project Planning practices.

Project Monitoring and Control practices also cover taking corrective action. The project plan specifies the appropriate level of project monitoring, the frequency of progress reviews, and the measures used to monitor progress. Progress is determined primarily by comparing project status to the plan. When the actual status deviates significantly from expected values, corrective actions are taken, as appropriate. These actions may include replanning, which requires using Project Planning practices.

As the acquirer's processes improve in capability, Integrated Project Management practices are used to manage the project using a defined process tailored from the organization's set of standard processes (Organizational Process Development). The project uses and contributes to the organization's process assets, the project's work environment is established and maintained from the organization's work environment standards, and integrated teams are established using the organization's rules and guidelines. The project's relevant stakeholders coordinate their efforts in a timely manner through the identification, negotiation, and tracking of critical dependencies and the resolution of coordination issues.

In the acquirer-supplier relationship, the need for an early and aggressive detection of risk is compounded by the complexity of projects acquiring products or services. The purpose of Risk Management is to identify and assess project risks during the project planning process and to manage these risks throughout the project.

The acquirer has a dual role: first, assess and manage overall project risks for the duration of the project, and second, assess and manage risks associated with the performance of the supplier. As the acquisition progresses to the selection of a supplier, the risks specific to the supplier's technical and management approach become more important to the success of the acquisition.

Although risk identification and monitoring are covered in the Project Planning and Project Monitoring and Control process areas, using the Risk Management process area enables the acquirer to take a continuing, forward-looking approach to managing risks with activities that include identification of risk parameters, risk assessments, and risk mitigation.

Acquisition Technical Management practices are used to combine the project's defined process and risk management activities to perform technical and interface management. This management includes activities such as managing the technical evaluation of selected supplier products and services, conducting technical reviews with the supplier, and managing selected interfaces throughout the project's lifecycle. Acquisition Technical Management practices, Agreement Management practices, and the Project Monitoring and Control practices are all used in concert, as they all contain reviews that are conducted throughout the project.

Using Acquisition Verification practices ensures that the acquirer's selected work products meet specified requirements. Using Acquisition Verification practices enables the acquirer to select work products and verification methods to verify acquirer work products against specified requirements.

Acquisition Verification practices also are used to address peer reviews. Peer reviews are a proven method for removing defects early and provide valuable insight into the work products and product components being developed and maintained by the acquirer.

The acquirer uses Acquisition Validation processes to ensure that the products or services received from the supplier will fulfill the relevant stakeholders' needs. Products and services are incrementally validated against the customer's needs.

Validation may be performed in the operational environment or in a simulated operational environment. Coordination with the customer on the validation requirements is an important element of this process area.

The scope of the Acquisition Validation process area includes the validation of products, product components, selected intermediate work products, and processes. These validated elements may often require reverification and revalidation. Issues discovered during validation are usually resolved using Acquisition Requirements Development practices or by working with the supplier through the supplier agreement and technical reviews.

As mentioned above, Integrated Project Management processes establish a defined process and integrated plan for managing all the activities of the project. These activities include all project processes described above, from Project Planning through Acquisition Validation. The organization's set of standard processes and other process assets provide critical guidance to projects for establishing a defined process and plan. How the organization creates and deploys such process assets for use by the whole organization, along with other forms of critical project support, is the subject of the next section.

Organizational Processes

Organizational process areas contain the cross-project activities related to defining, planning, deploying, implementing, monitoring, controlling, appraising, measuring, and improving processes.

The organizational process areas contain practices that provide the acquiring organization with a capability to develop and deploy processes and supporting assets and to document and share best practices and learning across the organization.

The organizational process areas of CMMI-ACQ are as follows:

- Organizational Process Focus (OPF)
- Organizational Process Definition (OPD)
- Organizational Training (OT)

Organizational Process Focus practices help the acquiring organization to plan, implement, and deploy organizational process improvements based on an understanding of the current strengths and weaknesses of the organization's processes and process assets. Candidate improvements to the organization's processes are obtained through activities in the processes of related projects. These activities include generating process improvement proposals, measuring processes, collecting lessons learned in implementing the processes, and evaluating products and services.

Using Organizational Process Focus practices, the acquirer encourages participation of suppliers in process improvement activities. Suppliers may be involved in developing process action plans if processes that define interfaces between the acquirer and supplier are targeted for improvement.

Organizational Process Definition practices form the basis for establishing and maintaining the organization's set of standard processes, work environment standards, rules and guidelines for the operation of integrated teams, and other assets based on the process needs and objectives of the organization.

These other assets include descriptions of lifecycle models, process tailoring guidelines, and process-related documentation and data. Projects tailor the organization's set of standard processes to create their defined processes using Integrated Project Management practices. Experiences and work products from performing these defined processes, including measurement data, process descriptions, process artifacts, and lessons learned, are incorporated, as appropriate, into the organization's set of standard processes and other assets.

The acquirer's set of standard processes may also describe standard interactions with suppliers. Supplier interactions are typically characterized by the deliverables expected from suppliers, acceptance criteria applicable to those deliverables, standards (e.g., architecture and technology standards), and standard milestone and progress reviews. The acquirer defines in the supplier agreement how changes to organizational process assets that impact the supplier (e.g., standard supplier deliverables and acceptance criteria) are deployed.

The purpose of implementing Organizational Training practices is to develop the skills and knowledge of people so they can perform their roles effectively and efficiently. For example, an acquiring organization may want to develop its project managers' capability in managing supplier agreements.

Using Organizational Training practices helps the acquirer identify the strategic training needs of the organization as well as the tactical training needs that are common across projects and support groups. In particular, training is created or obtained to develop the skills required to perform the organization's set of standard processes. The main components of training include a managed training development program, documented plans, personnel with appropriate knowledge, and mechanisms for measuring the effectiveness of the training program.

Support Processes

Support process areas cover the activities that support acquisition and address processes that are used in the context of performing other processes. The support process areas address acquisition project processes and may address processes that apply more generally to the organization. For example, Process and Product Quality Assurance practices can be used to provide an objective evaluation of the processes and work products described in all the process areas.

Although all support process areas rely on other process areas for input, some support process areas provide support functions that also help implement several generic practices.

The support process areas of CMMI-ACQ are as follows:

- Measurement and Analysis (MA)
- Process and Product Quality Assurance (PPQA)
- Configuration Management (CM)
- Decision Analysis and Resolution (DAR)

The Measurement and Analysis process area is related to other process areas because its practices guide projects and organizations in aligning measurement needs and objectives with a measurement approach that provides objective results. These results can be used in making informed decisions and taking appropriate corrective actions.

An acquirer uses Measurement and Analysis practices to support the information needs of the organization and project. Some of this information may be needed from the acquirer, some from the supplier, and some from all parts of a project. Supplier Solicitation and Agreement Development describes how these measures are specified in the solicitation process and supplier agreement. The measurement results from the acquirer and supplier support project, supplier, and technical reviews through project monitoring and control, agreement management, and acquisition technical management.

The Process and Product Quality Assurance process area is related to all process areas because it describes specific practices for objectively evaluating performed processes and work products against applicable process descriptions, standards, and procedures, and by ensuring that issues arising from these evaluations are addressed. Process and Product Quality Assurance practices support the acquisition of high-quality products and services by providing the acquirer with appropriate visibility into, and feedback on, the processes and associated work products throughout the life of the project.

The Configuration Management process area is related to all process areas because its practices describe establishing and maintaining the integrity of work products using configuration identification, configuration control, configuration status accounting, and configuration audits. The work products placed under configuration control include the products that are delivered to the customer, designated internal work products, acquired products, tools, and other items that are used in creating and describing these work products.

Examples of work products that may be placed under configuration control include plans, process descriptions, and requirements. Suppliers may play a part in any of these activities on behalf of the acquirer, so the supplier agreement should specify the configuration management roles and responsibilities of the acquirer and supplier. Configuration management of acquired products (both final and interim products) created by the suppliers requires monitoring to ensure that project requirements are met.

The Decision Analysis and Resolution process area is related to all process areas because its practices describe determining which issues should be subjected to a formal evaluation process and applying a formal evaluation process to them. A repeatable Decision Analysis and Resolution process is important for an acquirer when making the critical decisions that define and guide the acquisition process and later when critical decisions are made with the selected supplier.

High Maturity Processes

High maturity process areas describe practices that further align organizational, project, and support processes with the business objectives of the organization. These process areas describe practices at both the organizational and project level for establishing objectives for quality and process performance, monitoring variation in the organization's and projects' processes, evaluating the impacts of proposed changes to those processes, and systematically deploying processes across the organization. To effectively implement these practices, mature measurement and analysis processes are needed.

The acquirer achieves an effective implementation of high maturity practices by ensuring that all members of the organization collect and analyze measurements and propose and evaluate changes to processes. In other words, high maturity practices should be integrated as much as possible into the practices in other process areas.

The high maturity process areas of CMMI-ACQ are as follows:

- Organizational Process Performance (OPP)
- Quantitative Project Management (OPM)
- Causal Analysis and Resolution (CAR)
- Organizational Innovation and Deployment (OID)

At the organizational level, Organizational Process Performance practices are used to derive quantitative objectives for quality and process performance from the organization's business objectives. The organization provides projects and support groups with common measures, process-performance baselines, and process-performance models. These organizational assets support quantitative project management and the statistical management of critical subprocesses for both projects and support groups.

The organization analyzes the process-performance data collected from these defined processes to develop a quantitative understanding of product quality, service quality, and the performance of the organization's set of standard processes.

At the project level, acquirers use Quantitative Project Management practices when applying quantitative and statistical techniques to manage process performance and product quality. Quality and process-performance objectives for the project are based on the objectives established by the organization. Through an evaluation of which subprocesses will help the project best achieve its objectives, the project's defined process is composed.

The project's defined process comprises, in part, process elements and subprocesses for which process performance can be predicted. At a minimum, the process variation of subprocesses critical to achieving the project's quality and process-performance objectives must be understood. Corrective action is taken when special causes of process variation are identified.

Acquirers use Causal Analysis and Resolution practices to guide identification of root causes of selected defects and other problems and taking action to prevent their reoccurrence. While the project's defined processes are the principal targets for identifying the cause of the defect, the process improvement proposals they create target the organization's set of standard processes, which will prevent recurrence of the selected defects across the organization. These processes may be used to improve the performance of a subprocess, focusing on the central tendency of a product or process attribute, its spread, or both.

At the organizational level, Organizational Innovation and Deployment practices are used to select and deploy proposed incremental and innovative improvements that improve the organization's ability to meet its quality and process-performance objectives. Identifying promising incremental and innovative improvements should involve an empowered workforce aligned with the business values and objectives of the organization. The selection of improvements to deploy is based on a quantitative understanding of the benefits and costs of deploying candidate improvements, and the funding available.

Together, the high maturity processes enable the organization with an improved capability to achieve its quantitative objectives for quality and process performance.

5 Using CMMI Models

The complexity of today's products demands an integrated view of how organizations do business. CMMI can reduce the cost of process improvement across enterprises that depend on multiple functions or groups to produce products and services.

To achieve this integrated view, the CMMI Framework includes common terminology, common model components, common appraisal methods, and common training materials. This chapter describes how organizations can use the CMMI Product Suite not only to improve their quality, reduce their costs, and optimize their schedules, but also to gauge how well their process improvement program is working.

Adopting CMMI

Research has shown that the most powerful initial step to process improvement is to build organizational support through strong senior management sponsorship. To gain senior management sponsorship, it is often beneficial to expose senior management to the performance results experienced by others who have used CMMI to improve their processes [Gibson 2006].

For more information about CMMI performance results, see the SEI Web site at <http://www.sei.cmu.edu/cmmi/results.html>.

The senior manager, once committed as the process improvement sponsor, must be actively involved in the CMMI-based process improvement effort. Activities performed by the senior management sponsor include but are not limited to the following:

- Influence the organization to adopt CMMI
- Choose the best people to manage the process improvement effort
- Monitor the process improvement effort personally
- Be a visible advocate and spokesperson for the process improvement effort
- Ensure that adequate resources are available to enable the process improvement effort to be successful

Given sufficient senior management sponsorship, the next step is establishing a strong, technically competent process group that represents relevant stakeholders to guide process improvement efforts.

For an organization with a mission to develop software-intensive systems, the process group might include engineers representing the different technical disciplines across the organization and other selected members based on the business needs driving improvement. For example, a systems administrator may focus on information-technology support, whereas a marketing representative may focus on integrating customers' needs. Both members could make powerful contributions to the process group.

Once your organization decides to adopt CMMI, planning can begin with an improvement approach such as the IDEALSM (Initiating, Diagnosing, Establishing, Acting, & Learning) model [McFeeley 1996]. For more information about the IDEAL model, see the SEI Web site at <http://www.sei.cmu.edu/ideal/ideal.html>.

Your Process Improvement Program

Use the CMMI Product Suite to help establish your organization's process improvement program. Using the product suite for this purpose can be a relatively informal process that involves understanding and applying CMMI best practices to your organization. Or, it can be a formal process that involves extensive training, creation of a process improvement infrastructure, appraisals, and more.

Selections that Influence Your Program

You must make three selections to apply CMMI to your organization for process improvement:

1. Select a part of the organization.
2. Select a model.
3. Select a representation.

Selecting the projects to be involved in your process improvement program is critical. If you select a group that is too large, it may be too much for the initial improvement effort. The selection should also consider how homogeneous the group is (i.e., whether they all are software engineers, whether they all work on the same product or business line, and so on).

The process of selecting the representation to be used has some guidelines because of how CMMI models are built. If your organization likes the idea of maturity levels and the staged representation, your improvement roadmap is already defined. If your organization likes the continuous representation, you can select nearly any process area or group of process areas to guide improvement, although dependencies among process areas should be considered when making such a selection.

As the process improvement plans and activities progress, other important selections must be made, including which appraisal method should be used, which projects should be appraised, how training for personnel should be secured, and which personnel should be trained.

CMMI Models

CMMI models describe best practices that organizations have found to be productive and useful to achieving their business objectives. Regardless of your organization, you must use professional judgment when interpreting CMMI best practices for your situation, needs, and business objectives. Although process areas depict the characteristics of an organization committed to process improvement, you must interpret the process areas using an in-depth knowledge of CMMI, your organization, the business environment, and the specific circumstances involved.

As you begin using a CMMI model to improve your organization's processes, map your real-world processes to CMMI process areas. This mapping enables you to initially judge and later track your organization's level of conformance to the CMMI model you are using and to identify opportunities for improvement.

To interpret practices, it is important to consider the overall context in which these practices are used and to determine how well the practices satisfy the goals of a process area in that context. CMMI models do not prescribe nor imply processes that are right for any organization or project. Instead, CMMI describes minimal criteria necessary to plan and implement processes selected by the organization for improvement based on business objectives.

CMMI practices purposely use nonspecific phrases such as *relevant stakeholders*, *as appropriate*, and *as necessary* to accommodate the needs of different organizations and projects. The specific needs of a project may also differ at various points in its life.

Using CMMI Appraisals

Many organizations find value in measuring their progress by conducting an appraisal and earning a maturity level rating or a capability level achievement profile. These types of appraisals are typically conducted for one or more of the following reasons:

- To determine how well the organization's processes compare to CMMI best practices and identify areas where improvement can be made
- To inform external customers and suppliers about how well the organization's processes compare to CMMI best practices
- To meet the contractual requirements of one or more customers

Appraisals of organizations using a CMMI model must conform to the requirements defined in the Appraisal Requirements for CMMI (ARC) document. Appraisals focus on identifying improvement opportunities and comparing the organization's processes to CMMI best practices. Appraisal teams use a CMMI model and ARC-conformant appraisal method to guide their evaluation of the organization and their reporting of conclusions. The appraisal results are used (e.g., by a process group) to plan improvements for the organization.

Appraisal Requirements for CMMI

The Appraisal Requirements for CMMI (ARC) document describes the requirements for several types of appraisals. A full benchmarking class of appraisal is defined as a Class A appraisal method. Less formal methods are defined as Class B or Class C methods. The ARC document was designed to help improve consistency across appraisal methods and to help appraisal method developers, sponsors, and users understand the tradeoffs associated with various methods [SEI 2006c].

Depending on the purpose of the appraisal and the nature of the circumstances, one class may be preferred over the others. Sometimes self-assessments, initial appraisals, quick-look or mini-appraisals, incremental appraisals, or external appraisals are appropriate; at other times a formal benchmarking appraisal is appropriate.

A particular appraisal method is declared an ARC Class A, B, or C appraisal method based on the sets of ARC requirements that the method developer addressed when designing the method.

More information about the ARC is available on the SEI Web site at <http://www.sei.cmu.edu/cmmi/appraisals/index.html>.

SCAMPI Appraisal Methods

The SCAMPI A appraisal method is the generally accepted methods used for conducting ARC Class A appraisals using CMMI models. The SCAMPI A Method Definition Document (MDD) defines rules for ensuring the consistency of SCAMPI A appraisal ratings [SEI 2006b]. For benchmarking against other organizations, appraisals must ensure consistent ratings. The achievement of a specific maturity level or the satisfaction of a process area must mean the same thing for different appraised organizations.

The SCAMPI family of appraisals includes Class A, B, and C appraisal methods. The SCAMPI A appraisal method is the officially recognized and most rigorous method. It is the only method that can result in benchmark quality ratings. SCAMPI B and C appraisal methods provide organizations with improvement information that is less formal than the results of a SCAMPI A appraisal, but nonetheless helps the organization identify improvement opportunities.

More information about SCAMPI methods is available on the SEI Web site at <http://www.sei.cmu.edu/cmmi/appraisals/index.html>.

Appraisal Considerations

Choices that affect a CMMI-based appraisal include the following:

- The CMMI model
- The appraisal scope, including the organizational unit to be appraised, the CMMI process areas to be investigated, and the maturity level or capability levels to be appraised
- The appraisal method
- The appraisal team members
- The appraisal participants selected from the appraisal entities to be interviewed
- The appraisal outputs (e.g., ratings or instantiation-specific findings)
- The appraisal constraints (e.g., time spent on site)

The SCAMPI MDD allows the selection of predefined options for use in an appraisal. These appraisal options are designed to help organizations align CMMI with their business needs and objectives.

CMMI appraisal plans and results must always include a description of the appraisal options, model scope, and organizational scope selected. This documentation confirms whether an appraisal meets the requirements for benchmarking.

For organizations that wish to appraise multiple functions or groups, CMMI's integrated approach enables some economy of scale in model and appraisal training. One appraisal method can provide separate or combined results for multiple functions.

The appraisal principles for CMMI are the same as those used in appraisals for other process improvement models. Those principles are as follows:

- Senior management sponsorship⁹
- A focus on the organization's business objectives
- Confidentiality for interviewees
- Use of a documented appraisal method
- Use of a process reference model (e.g., a CMMI model) as a base
- A collaborative team approach
- A focus on actions for process improvement

CMMI-Related Training

Whether your organization is new to process improvement or is already familiar with process improvement models, training is a key element in the ability of organizations to adopt CMMI. An initial set of courses is provided by the SEI and its Partners, but your organization may wish to supplement these courses with its own instruction. This approach allows your organization to focus on areas that provide the greatest business value.

The SEI and its Partners offer a course that provides a basic overview of CMMI-ACQ. The SEI also offers the *Intermediate Concepts of CMMI* course to those who plan to become more deeply involved in CMMI adoption or appraisal—for example, those who will guide improvement as part of a process group, those who will lead SCAMPI appraisals, and those who will teach the *Introduction to CMMI* course.

Current information about CMMI-related training is available on the SEI Web site at <http://www.sei.cmu.edu/cmmi/training/index.html>.

⁹ Experience has shown that the most critical factor influencing successful process improvement and appraisals is senior management sponsorship.

PART TWO

Generic Goals and Generic Practices, and the Process Areas

GENERIC GOALS AND GENERIC PRACTICES

Overview

This section describes, in detail, all CMMI generic goals and generic practices—model components that directly address process institutionalization.

The text of the generic goals and generic practices is not repeated in the process areas. As you address each process area, refer back to this section for details of all generic practices.

Process Institutionalization

Institutionalization is an important concept in process improvement. When mentioned in the generic goal and generic practice descriptions, institutionalization implies that the process is ingrained in the way the work is performed and there is commitment and consistency to performing the process.

An institutionalized process is more likely to be retained during times of stress. When the requirements and objectives for the process change, however, the implementation of the process may also need to change to ensure that it remains effective. The generic practices describe activities that address these aspects of institutionalization.

The degree of institutionalization is embodied in the generic goals and in the names of the processes that correspond to each goal as indicated in Table 6.1.

Table 6.1: Generic Goals and Process Names

<i>Generic Goal</i>	<i>Progression of Processes</i>
GG 1	Performed process
GG 2	Managed process
GG 3	Defined process
GG 4	Quantitatively managed process
GG 5	Optimizing process

The progression of process institutionalization is characterized in the following descriptions of each process.

Performed Process

A performed process is a process that accomplishes the work necessary to produce work products. The specific goals of the process area are satisfied.

Managed Process

A managed process is a performed process that is planned and executed in accordance with policy; employs skilled people who have adequate resources to produce controlled outputs; involves relevant stakeholders; is monitored, controlled, and reviewed; and is evaluated for adherence to its process description. The process may be used by a project, group, or organizational function. Management of the process focuses on achieving the objectives established for the process, such as cost, schedule, and quality. The control provided by a managed process ensures that the established process is retained during times of stress.

The organization establishes requirements and objectives for the process. The status of the work products and delivery of the services are visible to management at defined points (e.g., at major milestones and completion of major tasks). Commitments are established among those performing the work and the relevant stakeholders and these commitments are revised as necessary. Work products are reviewed with relevant stakeholders and are controlled. The work products and services satisfy their specified requirements.

A critical distinction between a performed process and a managed process is the extent to which the process is managed. A managed process is planned (the plan may be part of a more encompassing plan) and the performance of the process is managed against the plan. Corrective actions are taken when the actual results deviate significantly from the plan. A managed process achieves the objectives of the plan and is institutionalized for consistent performance.

Defined Process

A defined process is a managed process that is tailored from the organization's set of standard processes according to the organization's tailoring guidelines; has a maintained process description; and contributes work products, measures, and other process improvement information to the organizational process assets.

The organizational process assets are artifacts that relate to describing, implementing, and improving processes. These artifacts are assets because they are developed or acquired to meet the business objectives of the organization, and they represent investments by the organization that are expected to provide current and future business value.

The organization's set of standard processes, which are the basis of the defined process, are established and improved over time. Standard processes describe fundamental process elements that are expected in defined processes. Standard processes also describe relationships (e.g., the ordering and the interfaces) among these process elements. The organization-level infrastructure to support current and future use of the organization's set of standard processes is established and improved over time. (See the definition of "standard process" in the glossary.)

A project's defined process provides a basis for planning, performing, and improving the project's tasks and activities. A project may have more than one defined process (e.g., one for developing the product and another for testing the product).

A defined process clearly states the following:

- Purpose
- Inputs
- Entry criteria
- Activities
- Roles
- Measures
- Verification steps
- Outputs
- Exit criteria

A critical distinction between a managed process and a defined process is the scope of application of the process descriptions, standards, and procedures. For a managed process, the process descriptions, standards, and procedures are applicable to a particular project, group, or organizational function. As a result, the managed processes of two projects in one organization may be different.

Another critical distinction is that a defined process is described in more detail and is performed more rigorously than a managed process. This means that improvement information is easier to understand, analyze, and use. Finally, management of the defined process is based on the additional insight provided by an understanding of the interrelationships of the process activities and detailed measures of the process, its work products, and its services.

Quantitatively Managed Process

A quantitatively managed process is a defined process that is controlled using statistical and other quantitative techniques. The product quality, service quality, and process-performance attributes are measurable and controlled throughout the project.

Quantitative objectives are established based on the capability of the organization's set of standard processes; the organization's business objectives; and the needs of the customer, end users, organization, and process implementers, subject to the availability of resources. The people performing the process are directly involved in quantitatively managing the process.

Quantitative management is performed on the overall set of processes that produces a product. The subprocesses that significantly contribute to overall process performance are statistically managed. For these selected subprocesses, detailed measures of process performance are collected and statistically analyzed. Special causes of process variation are identified and, as appropriate, the source of the special cause is addressed to prevent its recurrence.

Quality and process-performance measures are incorporated into the organization's measurement repository to support future fact-based decision making.

Activities for quantitatively managing the performance of a process include the following:

- Identifying subprocesses to be brought under statistical management
- Identifying and measuring product and process attributes important to quality and process performance
- Identifying and addressing special causes of subprocess variation (based on the selected product and process attributes and subprocesses selected for statistical management)
- Managing each selected subprocess to bring its performance within natural bounds (i.e., making the subprocess performance statistically stable and predictable based on the selected product and process attributes)
- Predicting the ability of the process to satisfy established quantitative quality and process-performance objectives
- Taking appropriate corrective actions when the established quantitative quality and process-performance objectives will not be satisfied

Corrective actions include updating the objectives or ensuring that relevant stakeholders have a quantitative understanding of, and have agreed to, the performance shortfall.

A critical distinction between a defined process and a quantitatively managed process is the predictability of process performance. The term *quantitatively managed* implies using appropriate statistical and other quantitative techniques to manage the performance of one or more critical subprocesses so the performance of the process can be predicted. A defined process provides only qualitative predictability.

Optimizing Process

An optimizing process is a quantitatively managed process that is adapted to meet current and projected business objectives. An optimizing process focuses on continually improving process performance through both incremental and innovative technological improvements. Process improvements that address common causes of process variation, root causes of defects, and other problems; and those that would measurably improve the organization's processes are identified, evaluated, and deployed, as appropriate. Improvements are selected based on a quantitative understanding of their expected contribution to achieving the organization's process improvement objectives versus the cost and impact to the organization.

Selected incremental and innovative technological process improvements are systematically managed and deployed into the organization. The effects of the deployed process improvements are measured and compared to quantitative process improvement objectives.

In an optimizing process, common causes of process variation are investigated to determine how to shift the mean or decrease variation in quality and process performance. Changes that support the achievement of the organization's process improvement objectives are candidates for deployment.

A critical distinction between a quantitatively managed process and an optimizing process is that the optimizing process is continuously improved by addressing common causes of process variation. A quantitatively managed process is concerned with addressing special causes of process variation and providing statistical predictability of results. Although the process may produce predictable results, the results may be insufficient to achieve the organization's process improvement objectives.

Relationships Among Processes

Generic goals evolve so that each goal provides a foundation for the next. Therefore, the following conclusions can be made:

- A managed process is a performed process.
- A defined process is a managed process.
- A quantitatively managed process is a defined process.
- An optimizing process is a quantitatively managed process.

Thus, applied sequentially and in order, the generic goals describe a process that is increasingly institutionalized from a performed process to an optimizing process.

Achieving GG 1 for a process area is equivalent to satisfying the specific goals of the process area.

Achieving GG 2 for a process area is equivalent to managing the performance of processes associated with the process area. There is a policy that indicates you will perform it. There is a plan for performing it. There are resources provided, responsibilities assigned, training on how to perform it, selected work products from performing the process are controlled, and so on. In other words, the process is planned and monitored just like any project or support activity.

Achieving GG 3 for a process area assumes that an organizational standard process exists that can be tailored to create the process you will use. Tailoring might result in making no changes to the standard process. In other words, the process used and the standard process may be identical. Using the standard process “as is” is tailoring because the choice is made that no modification is required.

Each process area describes multiple activities, some of which are repeatedly performed. You may need to tailor the way one of these activities is performed to account for new capabilities or circumstances. For example, you may have a standard for developing or obtaining organizational training that does not consider Web-based training. When preparing to develop or obtain a Web-based course, you may need to tailor the standard process to account for the challenges and benefits of Web-based training.

Achieving GG 4 or GG 5 for a process area is conceptually feasible but may not be economical except, perhaps, in situations in which the product domain is stable for an extended period or in situations in which the process area or domain is a critical business driver.

Generic Goals and Generic Practices

This section describes all of the generic goals and generic practices as well as their subpractices, notes, examples, and references. The generic goals are organized in numerical order, GG 1 through GG 5. The generic practices are also organized in numerical order under the generic goal they support.

As mentioned earlier in this chapter, the text of the generic practices is not repeated in the process areas; the text for each generic goal and generic practice is found only here.

GG 1 Achieve Specific Goals

The process supports and enables achievement of the specific goals of the process area by transforming identifiable input work products to produce identifiable output work products.

GP 1.1 Perform Specific Practices

Perform the specific practices of the process area to develop work products and provide services to achieve the specific goals of the process area.

The purpose of this generic practice is to produce the work products and deliver the services that are expected by performing the process. These practices may be done informally, without following a documented process description or plan. The rigor with which these practices are performed depends on the individuals managing and performing the work and may vary considerably.

GG 2 Institutionalize a Managed Process

The process is institutionalized as a managed process.

GP 2.1 Establish an Organizational Policy

Establish and maintain an organizational policy for planning and performing the process.

The purpose of this generic practice is to define the organizational expectations for the process and make these expectations visible to those in the organization who are affected. In general, senior management is responsible for establishing and communicating guiding principles, direction, and expectations for the organization.

Not all direction from senior management will bear the label *policy*. The existence of appropriate organizational direction is the expectation of this generic practice, regardless of what it is called or how it is imparted.

This policy establishes organizational expectations for planning and performing the process, including not only the elements of the process addressed directly by the acquirer but also the interactions of the acquirer with suppliers.

GP 2.2 Plan the Process

Establish and maintain the plan for performing the process.

The purpose of this generic practice is to determine what is needed to perform the process and achieve the established objectives, to prepare a plan for performing the process, to prepare a process description, and to get agreement on the plan from relevant stakeholders.

The practical implications of applying a generic practice vary for each process area.

For example, the planning described by this generic practice as applied to the Project Monitoring and Control process area may be carried out in full by the processes associated with the Project Planning process area. However, this generic practice, when applied to the Project Planning process area, sets an expectation that the project planning process itself be planned.

Therefore, this generic practice may either reinforce expectations set elsewhere in CMMI or set new expectations that should be addressed.

Refer to the Project Planning process area for more information about establishing and maintaining a project plan.

Establishing a plan includes documenting both the plan and the process. Maintaining the plan includes updating it to reflect corrective actions or changes in requirements or objectives.

The plan for performing the process typically includes the following:

- Process description
- Standards and requirements for the work products and services of the process
- Objectives for the performance of the process (e.g., quality, time scale, cycle time, and resource usage)
- Dependencies among activities, work products, and services of the process
- Resources (including funding, people, and tools) needed to perform the process
- Assignment of responsibility and authority
- Training needed for performing and supporting the process
- Work products to be controlled and the level of control to be applied
- Measurement requirements to provide insight into the performance of the process, its work products, and its services
- Involvement of identified stakeholders
- Activities for monitoring and controlling the process
- Objective evaluation activities of the process
- Management review activities for the process and the work products

Subpractices

1. Define and document the plan for performing the process.

This plan may be a stand-alone document, a plan embedded in a more comprehensive document, or a plan distributed across multiple documents. In the case of a plan being distributed across multiple documents, ensure that a coherent picture of who does what is preserved. Documents may be hardcopy or softcopy.

2. Define and document the process description.

The process description, which includes relevant standards and procedures, may be included as part of the plan for performing the process or may be referenced in the plan.

3. Review the plan with relevant stakeholders and get their agreement.

This review includes ensuring that the planned process satisfies the applicable policies, plans, requirements, and standards to provide assurance to relevant stakeholders.

4. Revise the plan as necessary.

GP 2.3	Provide Resources <p><i>Provide adequate resources for performing the process, developing the work products, and providing the services of the process.</i></p>
	<p>The purpose of this generic practice is to ensure that resources necessary to perform the process as defined by the plan are available when they are needed. Resources include adequate funding, appropriate physical facilities, skilled people, and appropriate tools.</p>
	<p>The interpretation of the term <i>adequate</i> depends on many factors and can change over time. Inadequate resources may be addressed by increasing resources or by removing requirements, constraints, and commitments.</p>
GP 2.4	Assign Responsibility <p><i>Assign responsibility and authority for performing the process, developing the work products, and providing the services of the process.</i></p>
	<p>The purpose of this generic practice is to ensure there is accountability for performing the process and achieving the specified results throughout the life of the process. The people assigned must have the appropriate authority to perform their assigned responsibilities.</p>
	<p>Responsibility can be assigned using detailed job descriptions or in living documents, such as the plan for performing the process. Dynamic assignment of responsibility is another legitimate way to perform this generic practice, as long as the assignment and acceptance of responsibility are ensured throughout the life of the process.</p>
	<p>Subpractices</p>
	<ol style="list-style-type: none">1. Assign overall responsibility and authority for performing the process.2. Assign responsibility and authority for performing the tasks of the process.3. Confirm that the people assigned to the responsibilities and authorities understand and accept them.
GP 2.5	Train People <p><i>Train the people performing or supporting the process as needed.</i></p>
	<p>The purpose of this generic practice is to ensure that the people have the necessary skills and expertise to perform or support the process.</p>

Appropriate training is provided to the people who will be performing the work. Overview training is provided to orient people who interact with those performing the work.

Examples of methods for providing training include self-study; self-directed training; self-paced, programmed instruction; formalized on-the-job training; mentoring; and formal and classroom training.

Training supports the successful performance of the process by establishing a common understanding of the process and by imparting the skills and knowledge needed to perform the process.

Experience (e.g., participation in a project with responsibility for managing some acquisition processes) may be substituted for training.

The acquisition organization should conduct a training needs analysis to understand its process training needs at both the organization and project levels. Then, appropriate training vehicles can be identified and provided to minimize process performance-related risks.

Refer to the Organizational Training process area for more information about training the people performing or supporting the process.

GP 2.6 Manage Configurations

Place designated work products of the process under appropriate levels of control.

The purpose of this generic practice is to establish and maintain the integrity of designated work products of the process (or their descriptions) throughout their useful life.

Designated work products are identified in the plan for performing the process, along with a specification of the appropriate level of control.

Different levels of control are appropriate for different work products and for different points in time. For some work products, it may be sufficient to maintain version control (i.e., the version of the work product in use at a given time, past or present, is known and changes are incorporated in a controlled manner). Version control is usually under the sole control of the work product owner (which may be an individual, a group, or a team).

Sometimes, it may be critical that work products be placed under formal or baseline configuration management. This type of control includes defining and establishing baselines at predetermined points. These baselines are formally reviewed and agreed on and serve as the basis for further development of designated work products.

Refer to the Configuration Management process area for more information about placing work products under configuration management.

Additional levels of control between version control and formal configuration management are possible. An identified work product may be under different levels of control at different points in time.

The acquirer is responsible for establishing and maintaining baselines and ensuring designated acquirer work products and supplier deliverables are placed under appropriate levels of control.

Examples of acquirer work products and supplier deliverables placed under control include the following:

- Project plans
- Solicitation packages
- Measures
- Product documentation

GP 2.7 Identify and Involve Relevant Stakeholders

Identify and involve the relevant stakeholders of the process as planned.

The purpose of this generic practice is to establish and maintain the expected involvement of stakeholders during the execution of the process.

Involve relevant stakeholders as described in an appropriate plan for stakeholder involvement. Involve stakeholders appropriately in activities such as the following:

- Planning
- Decisions
- Commitments
- Communication
- Coordination
- Reviews
- Appraisals
- Requirements definitions
- Resolution of problems/issues

Refer to the Project Planning process area for more information about planning for stakeholder involvement.

To plan stakeholder involvement, ensure that sufficient stakeholder interaction necessary to accomplish the process occurs, while avoiding excessive numbers of stakeholders that could impede process execution.

Examples of stakeholders that might serve as relevant stakeholders for acquisition tasks, depending on context, include the acquirer, customers, suppliers, end users, support personnel, other projects, and government regulators.

Subpractices

1. Identify stakeholders that are relevant to the process and plan their appropriate involvement.

Relevant stakeholders are identified among suppliers of inputs to, users of outputs from, and performers of activities within the process. Once relevant stakeholders are identified, the appropriate level of their involvement in process activities is planned.

2. Share these identifications with project planners or other planners, as appropriate.
3. Involve relevant stakeholders as planned.

GP 2.8

Monitor and Control the Process

Monitor and control the process against the plan for performing the process and take appropriate corrective action.

The purpose of this generic practice is to perform the direct day-to-day monitoring and controlling of the process. Appropriate visibility into the process is maintained so that appropriate corrective action can be taken when necessary. Monitoring and controlling the process involves measuring appropriate attributes of the process or work products produced by the process.

Refer to the Project Monitoring and Control process area for more information about monitoring and controlling the project and taking corrective action.

Refer to the Measurement and Analysis process area for more information about measurement.

The project collects and analyzes measurements from the acquirer and from the supplier to effectively monitor and control the project.

Subpractices

1. Measure actual performance against the plan for performing the process.

Measurements are collected from the process, its work products, and its services.

2. Review accomplishments and results of the process against the plan for performing the process.
3. Review activities, status, and results of the process with the immediate level of management responsible for the process and identify issues. Reviews are intended to provide the immediate level of management with appropriate visibility into the process. The reviews can be both periodic and event driven.
4. Identify and evaluate effects of significant deviations from the plan for performing the process.
5. Identify problems in the plan for performing the process and in the execution of the process.
6. Take corrective action when requirements and objectives are not being satisfied, when issues are identified, or when progress differs significantly from the plan for performing the process.

There are inherent risks that should be considered before corrective action is taken.

Corrective action may include the following:

- Taking remedial action to repair defective work products or services
- Changing the plan for performing the process
- Adjusting resources, including people, tools, and other resources
- Negotiating changes to established commitments
- Securing change to requirements and objectives that must be satisfied
- Terminating the effort

7. Track corrective action to closure.

GP 2.9 Objectively Evaluate Adherence

Objectively evaluate adherence of the process against its process description, standards, and procedures, and address noncompliance.

The purpose of this generic practice is to provide credible assurance that the process is implemented as planned and adheres to its process description, standards, and procedures. This generic practice is implemented, in part, by evaluating selected work products of the process. (See the definition of “objectively evaluate” in the glossary.)

Refer to the Process and Product Quality Assurance process area for more information about objectively evaluating adherence.

People not directly responsible for managing or performing the activities of the process typically evaluate adherence. In many cases, adherence is evaluated by people in the organization but external to the process or project or by people external to the organization. As a result, credible assurance of adherence can be provided even in times when the process is under stress (e.g., when the effort is behind schedule or over budget).

GP 2.10 Review Status with Higher Level Management

Review the activities, status, and results of the process with higher level management and resolve issues.

The purpose of this generic practice is to provide higher level management with appropriate visibility into the process.

Higher level management includes those levels of management in the organization above the immediate level of management responsible for the process. In particular, higher level management includes senior management. These reviews are for managers who provide the policy and overall guidance for the process and not for those who perform the direct day-to-day monitoring and controlling of the process.

Different managers have different needs for information about the process. These reviews help ensure that informed decisions on the planning and performing of the process can be made. Therefore, these reviews are both periodic and event driven.

Proposed changes to commitments to be made external to the organization (e.g., changes to supplier agreements) are typically reviewed with higher level management to obtain their concurrence with the proposed changes.

GG 3 Institutionalize a Defined Process

The process is institutionalized as a defined process.

GP 3.1 Establish a Defined Process

Establish and maintain the description of a defined process.

The purpose of this generic practice is to establish and maintain a description of the process that is tailored from the organization's set of standard processes to address the needs of a specific situation. The organization should have standard processes that cover the process area and have guidelines for tailoring these standard processes to meet the needs of a project or organizational function. With a defined process, variability in how the processes are performed across the organization is reduced and process assets, data, and learning can be effectively shared.

Refer to the Organizational Process Definition process area for more information about the organization's set of standard processes and tailoring guidelines.

Refer to the Integrated Project Management process area for more information about establishing and maintaining the project's defined process.

The descriptions of defined processes provide the basis for planning, performing, and managing activities, work products, and services associated with the process.

Subpractices

1. Select from the organization's set of standard processes those processes that best meet the needs of the project or organizational function.
2. Establish the defined process by tailoring the selected processes according to the organization's tailoring guidelines.
3. Ensure that the organization's process objectives are appropriately addressed in the defined process.
4. Document the defined process and records of tailoring.
5. Revise the description of the defined process as necessary.

GP 3.2 Collect Improvement Information

Collect work products, measures, measurement results, and improvement information derived from planning and performing the process to support the future use and improvement of the organization's processes and process assets.

The purpose of this generic practice is to collect information and artifacts derived from planning and performing the process. This generic practice is performed so that information and artifacts can be included in organizational process assets and made available to those who are (or who will be) planning and performing the same or similar processes. The information and artifacts are stored in the organization's measurement repository and the organization's process asset library.

Examples of relevant information include the effort expended for various activities, defects injected or removed in a particular activity, and lessons learned.

Refer to the Organizational Process Definition process area for more information about incorporating the work products, measures, measurement results, and improvement information into the organization's measurement repository and process asset library.

Refer to the Integrated Project Management process area for more information about contributing work products, measures, measurement results, and documented experiences to organizational process assets.

Subpractices

1. Store process and product measures and measurement results in the organization's measurement repository.

The process and product measures are primarily those defined in the common set of measures for the organization's set of standard processes.

2. Submit documentation for inclusion in the organization's process asset library.
3. Document lessons learned from the process for inclusion in the organization's process asset library.
4. Propose improvements to organizational process assets.

GG 4 Institutionalize a Quantitatively Managed Process

The process is institutionalized as a quantitatively managed process.

GP 4.1 Establish Quantitative Objectives for the Process

Establish and maintain quantitative objectives for the process, which address quality and process performance, based on customer needs and business objectives.

The purpose of this generic practice is to determine and obtain agreement from relevant stakeholders about quantitative objectives for the process. These quantitative objectives can be expressed in terms of product quality, service quality, and process performance.

Refer to the Quantitative Project Management process area for more information about establishing quantitative objectives for subprocesses of the project's defined process.

These quantitative objectives may be specific to the process or they may be defined for a broader scope (e.g., for a set of processes). In the latter case, these quantitative objectives may be allocated to some of the included processes.

These quantitative objectives are criteria used to judge whether the products, services, and process performance will satisfy the customers, end users, organization management, and process implementers.

These quantitative objectives go beyond the traditional end-product objectives. They also cover intermediate objectives used to manage the achievement of the objectives over time. They reflect, in part, the demonstrated performance of the organization's set of standard processes. These quantitative objectives should be set to values that are likely to be achieved when the processes or subprocesses involved are stable and within their natural bounds.

Subpractices

1. Establish quantitative objectives that pertain to the process.
2. Allocate quantitative objectives to the process or its subprocesses.

GP 4.2 Stabilize Subprocess Performance

Stabilize the performance of one or more subprocesses to determine the ability of the process to achieve the established quantitative quality and process-performance objectives.

The purpose of this generic practice is to stabilize the performance of one or more subprocesses of the defined process, which are critical contributors to overall performance, using appropriate statistical and other quantitative techniques. Stabilizing selected subprocesses supports predicting the ability of the process to achieve the established quantitative quality and process-performance objectives.

Refer to the Quantitative Project Management process area for more information about selecting subprocesses for statistical management, monitoring the performance of subprocesses, and other aspects of stabilizing subprocess performance.

A stable subprocess shows no significant indication of special causes of process variation. Stable subprocesses are predictable within the limits established by natural bounds of the subprocess. Variations in the stable subprocess are changes due to a common cause system.

Predicting the ability of the process to achieve the established quantitative objectives requires a quantitative understanding of the contributions of the subprocesses that are critical to achieving these objectives and establishing and managing against interim quantitative objectives over time.

Selected process and product measures and measurement results are incorporated into the organization's measurement repository to support process-performance analysis and future fact-based decision making.

Subpractices

1. Statistically manage the performance of one or more subprocesses that are critical contributors to the overall performance of the process.
2. Predict the ability of the process to achieve its established quantitative objectives considering the performance of the statistically managed subprocesses.
3. Incorporate selected process-performance measurement results into the organization's process-performance baselines.

GG 5 Institutionalize an Optimizing Process

The process is institutionalized as an optimizing process.

GP 5.1 Ensure Continuous Process Improvement

Ensure continuous improvement of the process in fulfilling the relevant business objectives of the organization.

The purpose of this generic practice is to select and systematically deploy process and technology improvements that contribute to meeting established quality and process-performance objectives.

Refer to the Organizational Innovation and Deployment process area for more information about selecting and deploying incremental and innovative improvements that measurably improve the organization's processes and technologies.

Optimizing processes to be agile and innovative depends on the participation of an empowered workforce aligned with the organization's business values and objectives. The organization's ability to rapidly respond to changes and opportunities is enhanced by finding ways to accelerate and share learning. Improvement of the processes is inherently part of everyone's role, resulting in a cycle of continual improvement.

Subpractices

1. Establish and maintain quantitative process improvement objectives that support the organization's business objectives.

The quantitative process improvement objectives may be specific to an individual process or they may be defined for a broader scope (i.e., for a set of processes), with individual processes contributing to achieving these objectives. Objectives that are specific to an individual process are typically allocated from quantitative objectives established for a broader scope.

These process improvement objectives are primarily derived from the organization's business objectives and from a detailed understanding of process capability. These objectives are the criteria used to judge whether process

performance is quantitatively improving the organization's ability to meet its business objectives. These process improvement objectives are often set to values beyond current process performance, and both incremental and innovative technological improvements may be needed to achieve these objectives. These objectives may also be revised frequently to continue to drive the improvement of the process (i.e., when an objective is achieved, it may be set to a new value that is again beyond the new process performance).

These process improvement objectives may be the same as, or a refinement of, objectives established in the Establish Quantitative Objectives for the Process generic practice, as long as they can serve as both drivers and criteria for successful process improvement.

2. Identify process improvements that will likely result in measurable improvements to process performance.

Process improvements include both incremental changes and innovative technological improvements. Innovative technological improvements are typically pursued as efforts that are separately planned, performed, and managed. Piloting is often performed. These efforts often target process factors that a process-performance analysis has determined to be key to significant measurable improvement.

3. Define strategies and manage the deployment of selected process improvements based on quantified expected benefits, estimated costs and impacts, and measured change to process performance.

The costs and benefits of these improvements are estimated quantitatively, and actual costs and benefits are measured. Benefits are primarily considered relative to the organization's quantitative process improvement objectives. Improvements are made to both the organization's set of standard processes and defined processes.

Managing the deployment of process improvements includes piloting changes and implementing adjustments as appropriate, addressing potential and real barriers to deployment, minimizing disruption to ongoing efforts, and managing risks.

GP 5.2 Correct Root Causes of Problems

Identify and correct the root causes of defects and other problems in the process.

The purpose of this generic practice is to analyze defects and other problems encountered in a quantitatively managed process, to correct the root causes of these types of defects and problems, and to prevent these defects and problems from occurring in the future.

Refer to the Causal Analysis and Resolution process area for more information about identifying and correcting root causes of selected defects. Even though the Causal Analysis and Resolution process area has a project context, it can be applied to processes in other contexts as well.

Root cause analysis can be applied beneficially to processes that are not quantitatively managed. However, the focus of this generic practice is to act on a quantitatively managed process, though the final root causes may be found outside of that process.

Applying Generic Practices

This section helps you to better understand the generic practices and provides information to help you interpret and apply generic practices in your organization.

Generic practices are model components applicable to all process areas. Think of generic practices as reminders. They remind you to do things right, and they are expected model components.

For example, when you are achieving the specific goals of the Project Planning process area, you are establishing and maintaining a plan that defines project activities. One of the generic practices that applies to the Project Planning process area is “Establish and maintain the plan for performing the process” (GP 2.2). When applied to this process area, this generic practice reminds you to plan the activities involved in creating the plan for the project.

When you are satisfying the specific goals of the Organizational Training process area, you are developing the skills and knowledge of people in your project and organization so that they can perform their roles effectively and efficiently. When applying the same generic practice (GP 2.2) to the Organizational Training process area, this generic practice reminds you to plan the activities involved in developing the skills and knowledge of people in the organization.

Process Areas that Support Generic Practices

While generic goals and generic practices are the model components that directly address the institutionalization of a process across the organization, many process areas likewise address institutionalization by supporting the implementation of generic practices. Knowing these relationships will help you effectively implement generic practices.

Such process areas contain one or more specific practices that when implemented may also fully implement a generic practice or generate a work product that is used in the implementation of a generic practice

An example is the Configuration Management process area and GP 2.6, “Place designated work products of the process under appropriate levels of control.” To implement the generic practice for one or more process areas, you might choose to implement the Configuration Management process area, all or in part, to implement the generic practice.

Another example is the Organizational Process Definition process area and GP 3.1, “Establish and maintain the description of a defined process.” To implement this generic practice for one or more process areas, you should first implement the Organizational Process Definition process area, all or in part, to establish the organizational process assets that are needed to implement the generic practice.

Table 6.2 describes (1) the process areas that support the implementation of generic practices and (2) the recursive relationships between generic practices and their closely related process areas. Both types of relationships are important to remember during process improvement to take advantage of the natural synergies that exist between the generic practices and their related process areas.

Table 6.2: Generic Practice and Process Area Relationships

Generic Practice	<i>Roles of Process Areas in Implementation of the Generic Practice</i>	<i>How the Generic Practice Recursively Applies to its Related Process Area(s)</i> ¹⁰
GP 2.2 Plan the Process	Project Planning: The project planning process can implement GP 2.2 in full for all project-related process areas (except for Project Planning itself).	GP 2.2 applied to the project planning process can be characterized as “plan the plan” and covers planning project planning activities.
GP 2.3 Provide Resources	Project Planning: The part of the project planning process that implements Project Planning SP 2.4, “Plan the Project’s Resources,” supports the implementation of GP 2.3 and GP 2.4 for all project-related process areas (except perhaps initially for Project Planning itself) by identifying needed project resources to ensure the proper staffing, facilities, equipment, and other assets needed by the project are secured.	
GP 2.4 Assign Responsibility		

¹⁰ When the relationship between a generic practice and a process area is less direct, the risk of confusion is reduced; therefore, we do not describe all recursive relationships in the table (e.g., for generic practices 2.3, 2.4, and 2.10).

Generic Practice	Roles of Process Areas in Implementation of the Generic Practice	How the Generic Practice Recursively Applies to its Related Process Area(s) ¹⁰
GP 2.5 Train People	<p>Organizational Training: The organizational training process supports the implementation of GP 2.5 as applied to all process areas by making the training that addresses strategic or organization-wide training needs available to those who will perform or support the process.</p>	<p>GP 2.5 applied to the organizational training process covers training for performing organizational training activities, which addresses the skills required to manage, create, and accomplish the training.</p>
GP 2.6 Manage Configurations	<p>Project Planning: The part of the project planning process that implements Project Planning SP 2.5, “Plan Needed Knowledge and Skills,” together with the organizational training process, support the implementation of GP 2.5 in full for all project-related process areas.</p>	<p>GP 2.6 applied to the configuration management process covers change and version control for work products produced by configuration management activities.</p>
GP 2.7 Identify and Involve Relevant Stakeholders	<p>Project Planning: The part of the project planning process that implements Project Planning SP 2.6, “Plan Stakeholder Involvement,” can implement the stakeholder identification part (first two subpractices) of GP 2.7 in full for all project-related process areas.</p>	<p>GP 2.7 applied to the project planning process covers the involvement of relevant stakeholders in project planning activities.</p>
	<p>Project Monitoring and Control: The part of the project monitoring and control process that implements Project Monitoring and Control SP 1.5, “Monitor Stakeholder Involvement,” can support implementing the third subpractice of GP 2.7 for all project-related process areas.</p>	<p>GP 2.7 applied to the project monitoring and control process covers the involvement of relevant stakeholders in project monitoring and control activities.</p>
	<p>Integrated Project Management: The part of the integrated project management process that implements Integrated Project Management SP 2.1, “Manage Stakeholder Involvement,” can support implementing the third subpractice of GP 2.7 for all project-related process areas.</p>	<p>GP 2.7 applied to the integrated project management process covers the involvement of relevant stakeholders in integrated project management activities.</p>

Generic Practice	Roles of Process Areas in Implementation of the Generic Practice	How the Generic Practice Recursively Applies to its Related Process Area(s) ¹⁰
GP 2.8 Monitor and Control the Process	<p>Project Monitoring and Control: The project monitoring and control process can implement GP 2.8 in full for all project-related process areas.</p> <p>Measurement and Analysis: For all processes, not just project-related processes, the Measurement and Analysis process area provides general guidance about measuring, analyzing, and recording information that can be used in establishing measures for monitoring actual performance of the process.</p>	GP 2.8 applied to the project monitoring and control process covers the monitoring and controlling of the project's monitor and control activities.
GP 2.9 Objectively Evaluate Adherence	<p>Process and Product Quality Assurance: The process and product quality assurance process can implement GP 2.9 in full for all process areas (except perhaps for Process and Product Quality Assurance itself).</p>	GP 2.9 applied to the process and product quality assurance process covers the objective evaluation of quality assurance activities.
GP 2.10 Review Status with Higher Level Management	<p>Project Monitoring and Control: The part of the project monitoring and control process that implements Project Monitoring and Control SP 1.6, "Conduct Progress Reviews," and SP 1.7, "Conduct Milestone Reviews," supports the implementation of GP 2.10 for all project-related process areas, perhaps in full, depending on higher level management involvement in these reviews.</p>	
GP 3.1 Establish a Defined Process	<p>Integrated Project Management: The part of the integrated project management process that implements Integrated Project Management SP 1.1, "Establish the Project's Defined Process," can implement GP 3.1 in full for all project-related process areas.</p> <p>Organizational Process Definition: For all processes, not just project-related processes, the organizational process definition process establishes the organizational process assets needed to implement GP 3.1.</p>	GP 3.1 applied to the integrated project management process covers establishing defined processes for integrated project management activities.

Generic Practice	Roles of Process Areas in Implementation of the Generic Practice	How the Generic Practice Recursively Applies to its Related Process Area(s) ¹⁰
GP 3.2 Collect Improvement Information	<p>Integrated Project Management: The part of the integrated project management process that implements Integrated Project Management SP 1.7, “Contribute to Organizational Process Assets,” can implement GP 3.2 in part or full for all project-related process areas.</p>	<p>GP 3.2 applied to the integrated project management process covers collecting improvement information derived from planning and performing integrated project management activities.</p>
GP 4.1 Establish Quantitative Objectives for the Process	<p>Organizational Process Focus: The part of the organizational process focus process that implements Organizational Process Focus SP 3.4, “Incorporate Experiences into Organizational Process Assets,” can implement GP 3.2 in part or full for all process areas.</p> <p>Organizational Process Definition: For all processes, the organizational process definition process establishes the organizational process assets needed to implement GP 3.2.</p>	<p>GP 4.1 applied to the quantitative project management process covers establishing quantitative objectives for quantitative project management activities.</p>
	<p>Quantitative Project Management: The part of the quantitative project management process that implements Quantitative Project Management SP 1.1, “Establish the Project’s Objectives,” supports the implementation of GP 4.1 for all project-related process areas by providing objectives from which the objectives for each particular process can be derived. If these objectives become established as part of implementing subpractices 5 and 8 of Quantitative Project Management SP 1.1, then the quantitative project management process implements GP 4.1 in full.</p> <p>Organizational Process Performance: The part of the organizational process performance process that implements Organizational Process Performance SP 1.3, “Establish Quality and Process-Performance Objectives,” supports the implementation of GP 4.1 for all process areas.</p>	<p>GP 4.1 applied to the organizational process performance process covers establishing quantitative objectives for organizational process-performance activities.</p>

Generic Practice	Roles of Process Areas in Implementation of the Generic Practice	How the Generic Practice Recursively Applies to its Related Process Area(s) ¹⁰
GP 4.2 Stabilize Subprocess Performance	<p>Quantitative Project Management: The part of the quantitative project management process that implements Quantitative Project Management SG 2, “Statistically Manage Subprocess Performance,” can implement GP 4.2 in full for all project-related process areas to which a statistically managed subprocess can be mapped.</p> <p>Organizational Process Performance: For all processes, not just project-related processes, the organizational process performance process establishes organizational process assets that may be needed to implement GP 4.2.</p>	GP 4.2 applied to the quantitative project management process covers stabilizing selected subprocesses of quantitative project management activities.
GP 5.1 Ensure Continuous Process Improvement	<p>Organizational Innovation and Deployment: The organizational innovation and deployment process can implement GP 5.1 in full for all process areas providing that quality and process-performance objectives for the organization have been defined. (The latter would be the case, say, if the Organizational Process Performance process area has been implemented.)</p>	GP 5.1 applied to the organizational innovation and deployment process covers ensuring continuous process improvement of organizational innovation and deployment activities.
GP 5.2 Correct Root Causes of Problems	<p>Causal Analysis and Resolution: The causal analysis and resolution process can implement GP 5.2 in full for all project-related process areas.</p>	GP 5.2 applied to the causal analysis and resolution process covers identifying root causes of defects and other problems in causal analysis and resolution activities.

Given the dependencies that generic practices have on these process areas, and given the more holistic view that many of these process areas provide, these process areas are often implemented early, in whole or in part, before or concurrent with implementing the associated generic practices.

There are also a few situations in which the result of applying a generic practice to a particular process area would seem to make a whole process area redundant, but, in fact, it does not. It may be natural to think that applying GP 3.1, Establish a Defined Process, to the Project Planning and Project Monitoring and Control process areas yields the same effect as the first specific goal of Integrated Project Management, "Use the Project's Defined Process."

Although it is true that there is some overlap, the application of the generic practice to these two process areas provides defined processes covering project planning and project monitoring and control activities. These defined processes do not necessarily cover support activities (such as configuration management), other project management processes (such as integrated project management), or the acquisition processes. In contrast, the project's defined process, provided by the Integrated Project Management process area, covers all appropriate processes.

AGREEMENT MANAGEMENT

An Acquisition Process Area at Maturity Level 2

Purpose

The purpose of Agreement Management (AM) is to ensure that the supplier and the acquirer perform according to the terms of the supplier agreement.

Introductory Notes

The Agreement Management process area involves the following activities:

- Executing the supplier agreement
- Monitoring supplier processes
- Accepting the delivery of acquired products
- Managing supplier invoices

The legal nature of many acquirer-supplier agreements makes it imperative that the project management team is acutely aware of the legal implications of actions taken when managing the acquisition of products or services.

The supplier agreement is the basis for managing the relationship with the supplier, including resolving issues. It defines the mechanisms that allow the acquirer to oversee the supplier's activities and evolving products and to verify compliance with supplier agreement requirements. It is also the vehicle for a mutual understanding between the acquirer and supplier. When the supplier's performance, processes, or products fail to satisfy established criteria as outlined in the supplier agreement, the acquirer may take corrective action.

Related Process Areas

Refer to the Project Monitoring and Control process area for more information about monitoring projects and taking corrective action.

Refer to the Measurement and Analysis process area for more information about specifying, analyzing, and reporting measures and how measurement data are analyzed and reported.

Refer to the Solicitation and Supplier Agreement Development process area for more information about establishing and maintaining the supplier agreement.

Refer to the Acquisition Validation process area for more information about validating products.

Refer to the Acquisition Technical Management process area for more information about evaluating supplier deliverables.

Specific Goal and Practice Summary

SG 1 Satisfy Supplier Agreements

- SP 1.1 Execute the Supplier Agreement
- SP 1.2 Monitor Selected Supplier Processes
- SP 1.3 Accept the Acquired Product
- SP 1.4 Manage Supplier Invoices

Specific Practices by Goal

SG 1 Satisfy Supplier Agreements

The terms of the supplier agreement are met by both the acquirer and the supplier.

SP 1.1 Execute the Supplier Agreement

Perform activities with the supplier as specified in the supplier agreement.

This specific practice covers internal and external communication as well as the use of information by the acquirer and supplier regarding the relationship, performance, results, and impact to the business. The acquirer manages the relationship with the supplier to maintain effective communication on key issues (e.g., changes in the acquirer's business), new supplier products and technologies, and changes in the organizational structure.

Refer to the Project Monitoring and Control process area for more information about monitoring projects and taking corrective action.

Typical Work Products

1. Integrated list of issues
2. Supplier project progress and performance reports
3. Supplier review materials and reports
4. Action items tracked to closure
5. Records of product and document deliveries

Typical Supplier Deliverables

1. Supplier project progress and performance reports
2. Corrective action results for supplier issues
3. Correspondence with the acquirer

Subpractices

1. Monitor supplier project progress and performance (e.g., schedule, effort, and cost) as defined in the supplier agreement.
2. Conduct management reviews with the supplier as specified in the supplier agreement.

Reviews cover both formal and informal reviews and include the following steps:

- Preparing for the review
- Ensuring that relevant stakeholders participate
- Conducting the review
- Identifying, documenting, and tracking all action items to closure
- Preparing and distributing to the relevant stakeholders a summary report of the review

Management reviews typically include the following:

- Reviewing critical dependencies
- Reviewing project risks involving the supplier
- Reviewing schedule and budget

Refer to the Project Monitoring and Control process area for more information about conducting project milestone reviews.

Refer to the Acquisition Technical Management process area for more information about conducting technical reviews.

3. Identify issues and determine corrective actions necessary to resolve and track them to closure.

Refer to the Manage Corrective Action to Closure specific goal in the Project Monitoring and Control process area for more information about tracking corrective actions to closure.

Unresolved issues escalate through the appropriate management chain according to the organization's issue resolution process.

4. Use the results of reviews to improve the supplier's performance and to establish and nurture long-term relationships with preferred suppliers.

The acquirer's evaluation of supplier performance is carried out primarily to confirm the supplier's competency or lack of competency relative to performing similar work on the project or other projects.

5. Monitor risks involving the supplier and take corrective action as necessary.

Refer to the Project Monitoring and Control process area for more information about monitoring project risks.

SP 1.2 Monitor Selected Supplier Processes

Select, monitor, and analyze supplier processes.

When there must be tight alignment between supplier and acquirer processes, the acquirer should monitor these processes to help prevent interface problems.

Selecting processes for monitoring involves considering the impact of the supplier's processes on the project. On larger projects with significant subcontracts for development of critical components, monitoring key processes is expected. For less critical components, the selection process may determine that monitoring is not appropriate. Between these extremes, the overall risk should be considered when selecting processes to be monitored.

Monitoring, if not performed with adequate care, can at one extreme be invasive and burdensome, or at the other extreme be uninformative and ineffective. The acquirer decides on the necessary level of monitoring depending on the level of risk if the supplier's process is not performed correctly. Monitoring activities can range from reviewing supplier-supplied process data to on-site appraisals of the supplier's processes [SEI 2007].

Analyzing selected processes involves taking the data obtained from monitoring the processes and analyzing them to determine whether there are serious issues.

Typical Work Products

1. List of processes selected for monitoring or rationale for non-selection
2. Activity reports
3. Performance reports
4. Performance curves
5. Discrepancy reports

Typical Supplier Deliverables

1. Supplier process quality assurance reports

Subpractices

1. Identify supplier processes critical to the success of the project.
2. Monitor selected supplier processes for compliance with requirements of the agreement.
3. Analyze results of monitoring selected processes to detect issues as early as possible that may affect the supplier's ability to satisfy requirements of the agreement.

Trend analysis can rely on internal and external data.

SP 1.3 Accept the Acquired Product

Ensure that the supplier agreement is satisfied before accepting the acquired product.

This practice involves ensuring that the acquired product meets all requirements and that customers concur before acceptance of the product. The acquirer ensures that all acceptance criteria have been satisfied and that all discrepancies have been corrected. Requirements for formal deliverable acceptance and how to address non-conforming deliverables are usually defined in the supplier agreement. The acquirer should be prepared to exercise all remedies if the supplier fails to perform.

The acquirer, usually through its authorized supplier agreement administrator, provides the supplier with formal written notice that supplier deliverables have been accepted or rejected.

Typically, an authorized representative of the acquirer assumes ownership of existing identified supplier products or deliverables tendered, or approves services rendered, as partial or complete performance of the supplier agreement.

The acquirer has defined how this product or service will make the transition to operations and support in the transition to operations and support plan. Transition to operations and support activities are monitored by the acquirer.

Refer to the Plan Transition to Operations and Support specific practice in the Project Planning process area for more information about planning for the transition of the accepted product or service.

Refer to the Monitor Transition to Operations and Support specific practice in the Project Monitoring and Control process area for more information about monitoring transition activities.

Typical Work Products

1. Stakeholder approval reports
2. Discrepancy reports
3. Product acceptance review report with approval signatures

Typical Supplier Deliverables

1. Work products as defined in the supplier agreement
2. Services as defined in the supplier agreement

Subpractices

1. Review the validation results, reports, logs, and issues for the acquired product.

Refer to the Acquisition Validation process area for more information about validating products.

2. Review supplier verification results, reports, logs, and issues for the acquired product.
3. Confirm that all contractual requirements for the acquired product are satisfied.

This subpractice may include confirming that appropriate license, warranty, ownership, usage, and support or maintenance agreements are in place and all supporting materials are received.

4. Confirm that all discrepancies have been corrected and all acceptance criteria have been satisfied.

5. Communicate to appropriate stakeholders that the supplier agreement has been satisfied.

The acquirer, usually through its authorized supplier agreement or contract administrator, provides the supplier with formal written notice that the supplier agreement has been satisfied so the supplier can be paid and the supplier agreement closed.

6. Communicate to relevant stakeholders the product's readiness for transition to operations and support.

SP 1.4

Manage Supplier Invoices

Manage invoices submitted by the supplier.

The intent of this practice is to ensure that payment terms defined in the supplier agreement are met and that supplier compensation is linked to supplier progress, as defined in the supplier agreement. This practice covers invoices for any type of charge (e.g., one-time, monthly, deliverable-based, pass-through). It covers invoice errors or issues, changes to invoices, billing errors, and withholding disputed charges consistent with the terms and conditions of the supplier agreement. The acquirer must also ensure that appropriate financial and invoice management controls are in place.

When accepting supplier deliverables, final payment should not be made to the supplier until it has been certified that all supplier deliverables meet contractual requirements and all acceptance criteria have been satisfied. When acceptance criteria have not been satisfied, the provisions of the supplier agreement may be exercised.

Typical Work Products

1. Invoices approved for payment

Typical Supplier Deliverables

1. Invoices

Subpractices

1. Receive invoices.
2. Review invoices and related supporting material.

Examples of areas of review for invoices and related support material include the following:

- Volumes for variable charges
- Pass through expenses
- Regulatory commitments related to payments
- Purchases made by the supplier on behalf of the acquirer

3. Resolve errors and manage issues with the supplier as required.
4. Approve invoices.

ACQUISITION REQUIREMENTS DEVELOPMENT

An Acquisition Process Area at Maturity Level 2

Purpose

The purpose of Acquisition Requirements Development (ARD) is to develop and analyze customer and contractual requirements.

Introductory Notes

This process area describes two types of requirements: customer requirements, which address the needs of relevant stakeholders for which one or more products and services will be acquired, and contractual requirements, which are the requirements to be addressed through the acquirer's relationship with suppliers and other appropriate organizations. Both sets of requirements must address needs relevant to later product lifecycle phases (e.g., operation, maintenance, support, and disposal) and key product attributes (e.g., safety, reliability, and maintainability).

In some acquisitions, the acquirer assumes the role of overall systems engineer, architect, or integrator for the product. In these acquisitions, the Requirements Development process area of CMMI-DEV should be used. Requirements Development in CMMI-DEV includes additional information helpful in these situations, including deriving and analyzing requirements at successively lower levels of product definition (e.g., establishing and maintaining product component requirements).

Requirements are the basis for the selection and design or configuration of the acquired product. The development of requirements includes the following activities:

- Elicitation, analysis, and validation of stakeholder needs, expectations, constraints, and interfaces to obtain customer requirements that constitute an understanding of what will satisfy stakeholders
- Development of the lifecycle requirements of the product (e.g., development, maintenance, transition to operations, decommissioning)
- Establishment of contractual requirements consistent with customer requirements to a level of detail that is sufficient to be included in the solicitation package and supplier agreement
- Development of the operational concept

- Analysis of needs and requirements (for each product lifecycle phase), the operational environment, and factors that reflect overall customer and end-user needs and expectations for attributes such as safety, security, and affordability

The requirements included in the solicitation package form the basis for evaluating proposals by suppliers and for further negotiations with suppliers and communication with the customer. The contractual requirements for the supplier are baselined in the supplier agreement.

Requirements are refined throughout the project lifecycle. Design decisions, subsequent corrective actions, and feedback during each phase of the project's lifecycle are analyzed for their impact on contractual requirements.

Requirements analyses aid understanding, defining, and selecting requirements at all levels from competing alternatives. Analyses occur recursively at successively more detailed levels until sufficient detail is available to produce contractual requirements and to further refine these, if necessary, while the supplier builds or configures the product.

Involvement of relevant stakeholders in both requirements development and analyses gives them visibility into the evolution of requirements. Participation continually assures stakeholders that requirements are being properly defined.

The Acquisition Requirements Development process area includes three specific goals. The Develop Customer Requirements specific goal addresses eliciting and defining a set of customer requirements. The Develop Contractual Requirements specific goal addresses defining contractual requirements that are based on customer requirements and are included in the solicitation package and supplier agreement. The specific practices of the Analyze and Validate Requirements specific goal support the development of the requirements in the first two specific goals. The specific practices associated with this specific goal cover analyzing and validating requirements with respect to the acquirer's intended environment.

Related Process Areas

Refer to the Requirements Management process area for more information about managing requirements and changes, obtaining agreement with the requirements provider, obtaining commitments with those implementing the requirements, and maintaining traceability.

Refer to the Solicitation and Supplier Agreement Development process area for more information about developing solicitation packages and supplier agreements.

Refer to the Acquisition Technical Management process area for more information about confirming that the resulting product meets contractual requirements.

Refer to the Acquisition Validation process area for more information about validating the acquired product or service against stakeholder needs, expectations, constraints, and interfaces.

Refer to the Risk Management process area for more information about identifying and managing risks that are related to requirements.

Specific Goal and Practice Summary

SG 1 Develop Customer Requirements

SP 1.1 Elicit Stakeholder Needs

SP 1.2 Develop and Prioritize Customer Requirements

SG 2 Develop Contractual Requirements

SP 2.1 Establish Contractual Requirements

SP 2.2 Allocate Contractual Requirements

SG 3 Analyze and Validate Requirements

SP 3.1 Establish Operational Concepts and Scenarios

SP 3.2 Analyze Requirements

SP 3.3 Analyze Requirements to Achieve Balance

SP 3.4 Validate Requirements

Specific Practices by Goal

SG 1 Develop Customer Requirements

Stakeholder needs, expectations, constraints, and interfaces are collected and translated into customer requirements.

Stakeholders (e.g., customers, end users, suppliers, testers, integrators, maintainers, operators, supplier agreement management personnel, manufacturers, and logistics support personnel) are sources of requirements. Their needs, expectations, constraints, interfaces, operational concepts, and product concepts are analyzed, harmonized, refined, and elaborated for translation into a set of customer requirements.

Frequently, stakeholder needs, expectations, constraints, and interfaces are poorly identified or conflicting. Since these needs, expectations, constraints, and interfaces must be clearly identified and understood throughout the project lifecycle, an iterative process is used throughout the life of the project to accomplish this objective. To facilitate the required interaction, relevant stakeholders are frequently involved throughout the project lifecycle to communicate their needs, expectations, and constraints, and to help resolve conflicts. Environmental, legal, and other constraints should be considered when creating and evolving the set of requirements for acquiring products or services.

SP 1.1

Elicit Stakeholder Needs

Elicit stakeholder needs, expectations, constraints, and interfaces for all phases of the product lifecycle.

Eliciting goes beyond collecting needs by proactively identifying additional needs not explicitly provided by stakeholders. Relevant stakeholders who represent all phases of the product lifecycle in the acquirer's intended environment should include business as well as technical functions. Using this approach, needs for all product-related lifecycle processes are considered concurrently with concepts for acquired products.

An analysis of business processes is a common source of stakeholder needs, expectations, constraints, and interfaces. Additional needs typically address project lifecycle activities and their impact on the product.

Examples of techniques to elicit needs from stakeholders include the following:

- Questionnaires and interviews
- Operational scenarios obtained from end users
- Operational walkthroughs and end-user task analyses
- Prototypes and models
- Observation of existing products, environments, and workflow patterns
- Technology demonstrations
- Interim project reviews
- Brainstorming
- Quality Function Deployment
- Market surveys
- Extraction from sources such as business process documents, standards, or specifications
- Use cases
- Business case analyses
- Reverse engineering (for legacy products)

Examples of sources of requirements that might not be identified by the customer include the following:

- Government regulations
- Policies and standards
- Technology
- Legacy products or product components (for reuse)

Typical Work Products

1. Stakeholder needs, expectations, constraints, and interfaces

Subpractices

1. Engage relevant stakeholders using methods for eliciting needs, expectations, constraints, and external interfaces.

SP 1.2 Develop and Prioritize Customer Requirements

Transform stakeholder needs, expectations, constraints, and interfaces into prioritized customer requirements.

The customer typically describes requirements as capabilities expressed in broad operational terms concerned with achieving a desired effect under specified standards and regulations. Customer requirements may also include needs, expectations, constraints, and interfaces with regard to verification and validation. Inputs from the customer and other stakeholders must be aligned to the organization's strategy. Missing information must be obtained and conflicts must be resolved as customer requirements are developed and prioritized.

Customer requirements may also exist as an output of another project's activities such as a previous project that delivered the initial capability.

Examples of factors to consider when expressing customer requirements include the following:

- Key characteristics (attributes) of the desired capability with appropriate parameters and measures
- Obstacles to overcome to achieve the capability
- Competitive gap between the existing and the desired capability
- Supportability of the desired capability
- Level of detail of customer requirements that does not prejudice decisions in favor of a particular means of implementation but are specific enough to evaluate alternative approaches to implement the capability

Typical Work Products

1. Prioritized customer requirements
2. Customer constraints on the conduct of verification
3. Customer constraints on the conduct of validation

Subpractices

1. Translate stakeholder needs, expectations, constraints, and interfaces into documented customer requirements.
2. Establish and maintain a prioritization of customer requirements.

Having prioritized customer requirements guides the acquirer in determining project scope and which requirements and requirements changes to include in supplier agreements. This prioritization ensures that requirements critical to the customer and other stakeholders are addressed quickly.

Determining priorities and resolving conflicts among them can be addressed when eliciting stakeholder needs, as described in the previous specific practice.

3. Define constraints for verification and validation.

SG 2 Develop Contractual Requirements

Customer requirements are refined and elaborated into contractual requirements.

Customer requirements are analyzed in conjunction with the development of the operational concept to derive more detailed and precise sets of requirements, called contractual requirements, to be included in the solicitation package for potential suppliers and eventually in the supplier agreement. The level of detail of contractual requirements is based on the acquisition strategy and project characteristics.

Contractual requirements arise from constraints, consideration of issues implied but not explicitly stated in the customer requirements baseline, and factors introduced by design constraints and supplier capabilities. Contractual requirements include both requirements documented in contracts between an acquirer and supplier and requirements addressed through formal agreements between the acquirer and other organizations (e.g., partners, subcontractors, government agencies, and internal organizational units). (See the definition of “contractual requirements” in the glossary.) Requirements are reexamined throughout the project lifecycle.

The requirements are allocated to supplier deliverables. The traceability across levels of requirements and supplier deliverables is documented.

Refer to the Maintain Bidirectional Traceability of Requirements specific practice of the Requirements Management process area for more information about maintaining bidirectional traceability.

SP 2.1 Establish Contractual Requirements

Establish and maintain contractual requirements that are based on customer requirements.

Customer requirements may be expressed in the customer's terms and may be nontechnical descriptions. Contractual requirements are the expression of these requirements in technical terms that can be used for design decisions.

In addition to technical requirements (e.g., requirements specifying interfaces with other products or applications, functional requirements and their validation, technical performance measures, and verification requirements such as product acceptance criteria), contractual requirements cover nontechnical stakeholder needs, expectations, constraints, and interfaces.

Examples of nontechnical requirements include the following:

- Frequency and format of supplier reviews
- Supplier reports and other communication
- Availability of support to meet levels of the business process or product performance
- Warranty of products provided by a supplier
- Logistics support that sustains both short- and long-term readiness
- Minimal total lifecycle cost to own and operate (i.e., minimal total ownership cost)
- Maintenance concepts that optimize readiness while drawing on both acquirer and supplier sources
- Data management and configuration management that facilitates cost-effective product support throughout the product's use by the acquirer

The modification of requirements due to approved requirement changes is covered by the *maintain* function of this specific practice; whereas, the administration of requirement changes is covered by the Requirements Management process area.

Refer to the Requirements Management process area for more information about managing changes to requirements.

Typical Work Products

1. External interface requirements
2. Contractual requirements
3. Contractual requirements priorities

Subpractices

1. Develop functional and performance requirements necessary for the determination of alternative solutions and the development of the product by the supplier.

Priorities may be assigned to product requirements to provide a basis for future requirements tradeoffs should this become necessary. Acquirers may assign priorities using categories such as Essential, Important, or Desirable.

2. Develop interface requirements of the acquired product to other products in the intended environment.

Requirements for interfaces are defined in terms of origination, destination, stimulus, data characteristics for software, and electrical and mechanical characteristics for hardware.

3. Develop design constraints necessary for the determination of alternative solutions and the development of the product by the supplier.

Design constraints express the qualities and technical performance that are critical to the success of the product in its intended operational environment. They account for customer requirements relative to product interoperability, implications from the use of commercial off-the-shelf (COTS) products, safety, security, durability, and other mission-critical concerns.

To achieve high levels of reuse and interoperability, acquirers may establish common design constraints for products or product families that can be deployed in one or more domains. Alternatively, acquirers may accelerate the development of technical requirements and design constraints by reusing shared or common constraints or requirements and their associated test cases from previous acquisitions or leverage the supplier's previous product developments.

4. Develop requirements for verification and validation of the product to be developed by the supplier.

Requirements for verification and validation typically include types and coverage of testing and review to be carried out in the supplier's and acquirer's environments.

Testing requirements may include mirroring the production environment of the acquirer, the type of test data to be used, and simulated testing of interfaces with other products.

5. Establish and maintain relationships among the requirements under consideration during change management and requirements allocation.

Relationships between requirements can affect evaluating the impact of requirements changes. Expected requirements volatility is a key factor in anticipating scope changes and supporting the acquirer's selection of the appropriate acquisition type.

6. Identify nontechnical requirements.

Contractual requirements consist of both technical and nontechnical requirements. Examples of nontechnical requirements are listed in the example box in this specific practice.

7. Establish and maintain a prioritization of contractual requirements.

Priority can be based on a combination of several factors that include customer desires, costs, timeframe for when the capabilities are needed, and length of time to satisfy a particular requirement.

When cost estimates can be determined for contractual requirements, their priority and costs can be used to guide contract and budget negotiations and to determine which changes should be made to the contract.

Priority may also help when developing a release strategy (e.g., first release only addresses high-priority requirements; lower priority requirements are deferred to a later release or maintenance phase).

Refer to the Project Planning process area for more information about establishing an acquisition strategy and estimating costs associated with requirements.

SP 2.2 Allocate Contractual Requirements

Allocate contractual requirements to supplier deliverables.

Contractual requirements are allocated, as appropriate, to supplier deliverables. The requirements for each supplier deliverable are documented. In some cases, technical requirements are allocated to third-party products that must be used by the supplier (e.g., COTS products).

Typical Work Products

1. Requirement allocation sheets

Subpractices

1. Allocate requirements to supplier deliverables.
2. Allocate design constraints to supplier deliverables.

3. Document relationships among allocated requirements and design constraints.

Relationships include dependencies (i.e., a change in one requirement may affect other requirements).

4. Allocate requirements to suppliers.

In situations where multiple suppliers are involved in developing the technical solution, different products or product components may be allocated to different suppliers.

SG 3 Analyze and Validate Requirements

Requirements are analyzed and validated.

Analyses are performed to determine the impact the intended operational environment will have on the ability to satisfy stakeholder needs, expectations, constraints, and interfaces. Considerations such as feasibility, mission needs, cost constraints, potential market size, and acquisition strategy, must all be taken into account, depending on the product context.

The objectives of these analyses are (1) to determine candidate requirements for product concepts that will satisfy stakeholder needs, expectations, constraints, and interfaces and (2) to translate these concepts into requirements. In parallel with these activities, the parameters to be used to evaluate the effectiveness of the product are determined based on customer input and the preliminary product concept.

Requirements are validated to increase the probability that the resulting product will perform as intended in the acquirer's environment.

SP 3.1 Establish Operational Concepts and Scenarios

Establish and maintain operational concepts and associated scenarios.

Operational concepts or concepts of operations is an overall description of the problem to be solved in operational terms and the way in which the product to be acquired is intended to be used or operated, deployed, supported (including maintenance and sustainment), and disposed. The acquirer explicitly accounts for design constraints.

For example, the operational concept for a satellite-based communications product is quite different from one based on landlines.

In contrast, an operational scenario is a description of a sequence of events that might occur in the use of the product to be acquired and makes explicit some stakeholder needs. Typically, operational scenarios are derived from business process descriptions and operational concepts.

Operational concepts and scenarios can assist in the elicitation of needs and the analysis and refinement of requirements. Operational concepts and scenarios can be further refined as solution decisions are made and more detailed requirements are developed. They are evolved to facilitate the validation of technical solutions delivered by the supplier.

Typical Work Products

1. Operational, maintenance, support, and disposal concepts
2. Use cases
3. New requirements

Subpractices

1. Develop operational concepts and scenarios that include functionality, performance, maintenance, support, and disposal, as appropriate.
2. Define the environment in which the product will operate, including boundaries and constraints.
3. Review operational concepts and scenarios to refine and discover requirements.

Operational concept and scenario development is an iterative process. Reviews should be held periodically to ensure that the operational concepts and scenarios agree with the requirements. The review may be in the form of a walkthrough.

4. Develop a detailed operational concept, as candidate solutions are identified and product and product component solutions are selected by the supplier, that defines the interaction of the product, the end user, and the environment, and that satisfies operational, maintenance, support, and disposal needs.

SP 3.2 Analyze Requirements

Analyze requirements to ensure they are necessary and sufficient.

As contractual requirements are defined, their relationship to customer requirements must be understood. In light of the operational concepts and scenarios, the contractual requirements are analyzed to determine whether they are necessary and sufficient to meet customer requirements. The analyzed requirements then provide the basis for more detailed and precise requirements throughout the project lifecycle.

One of the other actions is the determination of which key requirements will be used to track technical progress. For instance, the weight of a product or size of a software product may be monitored through development based on its risk.

Refer to the Acquisition Technical Management process area for more information about tracking technical progress and technical performance measures.

Typical Work Products

1. Requirements defects reports
2. Proposed requirements changes to resolve defects
3. Key requirements
4. Technical performance measures

Subpractices

1. Analyze stakeholder needs, expectations, constraints, and external interfaces to remove conflicts and to organize into related subjects.
2. Analyze requirements to determine whether they satisfy higher level requirements.
3. Analyze requirements to ensure that they are complete, feasible, realizable, and verifiable.
4. Analyze and propose the allocation of requirements to supplier deliverables.
5. Identify key requirements that have a strong influence on cost, schedule, functionality, risk, or performance.
6. Identify technical performance measures to be tracked during the acquisition.

Technical performance measures are precisely defined measures based on a product requirement, product capability, or some combination of requirements and/or capabilities. Technical performance measures are chosen to monitor requirements and capabilities that are considered key factors in a product's performance. Data for technical performance measures are provided by the supplier as specified in the supplier agreement.

Refer to the Measurement and Analysis process area for more information about specifying measures.

7. Analyze operational concepts and scenarios to refine customer needs, constraints, and interfaces and to discover new requirements.

This analysis may result in more detailed operational concepts and scenarios as well as support the derivation of new requirements.

SP 3.3 Analyze Requirements to Achieve Balance

Analyze requirements to balance stakeholder needs and constraints.

Stakeholder needs and constraints can address cost, schedule, performance, functionality, reusable components, maintainability, or risk.

Requirements are analyzed to determine whether they reflect an appropriate balance among cost, schedule, performance, and other factors of interest to relevant stakeholders. Models and simulations can be used to estimate the impacts that requirements will have on these factors. By involving stakeholders from different phases of the product's lifecycle in analyzing these impacts, risks can be determined. If the risks are considered unacceptable, the requirements may be revised or reprioritized to improve the balance of cost, schedule, and performance.

Typical Work Products

1. Assessment of risks related to requirements

Subpractices

1. Use proven models, simulations, and prototyping to analyze the balance of stakeholder needs and constraints.

Results of analyses can be used to reduce the cost of the product and the risk in acquiring and using the product.

2. Perform a risk assessment on requirements and design constraints.

Refer to the Risk Management process area for more information about performing a risk assessment on customer and contractual requirements and design constraints.

3. Examine product lifecycle concepts for impacts of requirements on risks.

SP 3.4 Validate Requirements

Validate requirements to ensure the resulting product performs as intended in the user's environment.

Requirements validation is performed early in the acquisition with end users or their representatives to gain confidence that the requirements are capable of guiding a development that results in successful final validation. This activity should be integrated with risk management activities. Mature organizations typically perform requirements validation in a more sophisticated way using multiple techniques and broaden the basis of the validation to include other stakeholder needs and expectations. These organizations typically perform analyses, prototyping, and simulations to ensure that requirements will satisfy stakeholder needs and expectations.

Examples of techniques used for requirements validation include the following:

- Analysis
- Simulations
- Prototyping
- Demonstrations

Typical Work Products

1. Records of analysis methods and results

Typical Supplier Deliverables

1. Requirements and validation methods (e.g., prototypes and simulations)

Subpractices

1. Analyze the requirements to determine the risk that the resulting product will not perform appropriately in its intended-use environment.
2. Explore the adequacy and completeness of requirements by developing product representations (e.g., prototypes, simulations, models, scenarios, and storyboards) and by obtaining feedback about them from relevant stakeholders.

Refer to the Acquisition Validation process area for more information about preparing for and performing validation on products and product components.

3. Assess product and product component solutions as they are developed by the supplier in the context of the validation environment to identify issues and expose unstated needs and customer requirements.

ACQUISITION TECHNICAL MANAGEMENT

An Acquisition Process Area at Maturity Level 3

Purpose

The purpose of Acquisition Technical Management (ATM) is to evaluate the supplier's technical solution and to manage selected interfaces of that solution.

Introductory Notes

The Acquisition Technical Management process area focuses on the following:

- Conducting technical reviews of the supplier's technical solution
- Analyzing the development and implementation of the supplier's technical solution to confirm technical progress criteria or contractual requirements are satisfied
- Managing selected interfaces

Typically, these activities interactively support one another to gauge technical progress and allow effective management of project technical risks. Different levels of detailed analysis, depending on the development progress and insight required, may be needed to conduct technical reviews to the acquirer's satisfaction. Prototypes, simulations, and technology demonstrations created by the supplier may be used as a means of gaining knowledge to manage selected interfaces.

In some acquisitions, the acquirer assumes the role of overall systems engineer, architect, or integrator for the product. In these acquisitions, the Technical Solution process area of CMMI-DEV should be used. Technical Solution in CMMI-DEV includes additional information about designing, developing, and implementing solutions, including the design approaches, design concepts, and alternative solutions for which an acquirer may have varying degrees of responsibility.

Acquisition Technical Management activities involve measuring technical progress and the effectiveness of plans and requirements. Activities include those associated with technical performance measurement and the conduct of technical reviews. A structured review process should demonstrate and confirm completion of required accomplishments and exit criteria as defined in project planning and technical plans (e.g., the Systems Engineering Management Plan). Acquisition Technical Management activities discover deficiencies or anomalies that often result in corrective action.

Acquisition Technical Management should be performed with other technical and agreement management processes, such as requirements management, risk management, configuration management, data management, and agreement management.

Related Process Areas

Refer to the Acquisition Requirements Development process area for more information about allocating requirements, establishing an operational concept, specifying technical performance measures, and defining interface requirements.

Refer to the Decision Analysis and Resolution process area for more information about establishing evaluation criteria and selecting alternatives based on those criteria.

Refer to the Requirements Management process area for more information about managing requirements.

Refer to the Risk Management process area for more information about managing risks.

Refer to the Configuration Management process area for more information about managing configuration items.

Refer to the Plan Data Management specific practice of the Project Planning process area for more information about managing data.

Refer to the Agreement Management process area for more information about managing the supplier agreement.

Specific Goal and Practice Summary

SG 1 Evaluate Technical Solutions

- SP 1.1 Select Technical Solutions for Analysis
- SP 1.2 Analyze Selected Technical Solutions
- SP 1.3 Conduct Technical Reviews

SG 2 Perform Interface Management

- SP 2.1 Select Interfaces to Manage
- SP 2.2 Manage Selected Interfaces

Specific Practices by Goal

SG 1 Evaluate Technical Solutions

Supplier technical solutions are evaluated to confirm that contractual requirements continue to be met.

Technical reviews (or architectural evaluations) are performed throughout the project lifecycle to gain confidence that the requirements, architecture, and supplier technical solutions are capable of guiding a development that results in a product or service that provides the required capability. This activity should be integrated with risk management activities. Mature organizations typically perform technical reviews using different proven techniques depending on the type of review. They broaden the basis of the review to include other stakeholder needs, expectations, and constraints.

Refer to the Establish the Acquisition Strategy specific practice in the Project Planning process area for more information about specifying technical performance measures and their threshold values.

This specific goal focuses on the following:

- Selecting supplier technical solutions (i.e., preliminary designs, detailed designs, and design implementations) based on sound decision-making criteria
- Analyzing selected supplier technical solutions
- Conducting technical reviews using results of the analysis

SP 1.1 Select Technical Solutions for Analysis

Select supplier technical solutions to be analyzed and analysis methods to be used.

The supplier technical solutions are typically in one of the following three stages:

- Candidate solutions (i.e., *design approaches*, *design concepts*, or *preliminary designs*) that potentially satisfy an appropriate set of allocated requirements
- Detailed designs for selected solutions (i.e., containing all the information needed to manufacture, code, or otherwise implement the design as a product or product component)
- Implemented designs (i.e., the product or service)

Depending on where in the acquisition lifecycle the highest risks occur, the acquirer selects supplier technical solutions for analysis to reduce those risks. Analysis methods are selected based on the type of technical solution being analyzed.

For example, in the implementation phase of the supplier technical solution, the acquirer may examine a product to determine if it is ready for production and if the supplier has accomplished adequate production planning. The analysis would determine if production or production preparations incur unacceptable risks that might compromise schedule, performance, cost, or other established objectives. The acquirer might evaluate the full, production-configured product to determine if it correctly and completely implements all contractual requirements. The acquirer could also determine whether the traceability of the final contractual requirements to the final production-configured product has been maintained.

The acquirer may want to select interfaces for analysis to help decide which interfaces require acquirer management. (See specific goal 2 of this process area.)

Typical Work Products

1. Criteria used for selecting supplier technical solutions for analysis
2. Lists of supplier technical solutions selected for analysis
3. Analysis methods for each selected supplier solution

Typical Supplier Deliverables

1. List of supplier deliverables

Subpractices

1. Select criteria for determining which supplier technical solutions to analyze.

Refer to the Decision Analysis and Resolution process area for more information about establishing evaluation criteria used in making decisions.

2. Identify supplier technical solutions for analysis.

Supplier technical solutions that are typically analyzed by the acquirer include the following:

- Supplier-derived product and product component requirements, architectures, and designs
- Product interface descriptions
- Products and product components
- Operations manuals
- Plans for training the operations staff

3. Identify the requirements to be satisfied by each selected technical solution.

A traceability matrix is a useful tool for identifying requirements for each selected technical solution, as it typically includes information that relates requirements to work products. When identifying requirements for each selected technical solution, consult the appropriate traceability matrix.

Refer to the Maintain Bidirectional Traceability of Requirements specific practice in the Requirements Management process area for more information about tracing requirements to work products.

4. Identify the analysis methods to be used for each selected technical solution.

Examples of techniques used for analysis include the following:

- Simulations
- Architectural prototyping
- Demonstrations

5. Include analysis methods and review activities in the project plan.

Refer to the Project Planning process area for more information about planning the technical aspects of the project.

SP 1.2 Analyze Selected Technical Solutions

Analyze selected supplier technical solutions.

Depending on the type of technical solution being analyzed (i.e., preliminary design, detailed design, or design implementation), the results of the analysis are provided to the technical review described in the next specific practice.

For example, the acquirer should assess the design as it matures in the context of the requirements to identify issues and expose unstated needs and customer requirements.

The acquirer should select a supplier's design to analyze by exploring the adequacy and completeness of that design by reviewing product representations (e.g., prototypes, simulations, models, scenarios, and storyboards) and by obtaining feedback about them from relevant stakeholders.

The acquirer should confirm the following:

- The selected design adheres to applicable design standards and criteria
- The design adheres to allocated requirements
- The resulting product will perform appropriately in its intended-use environment

During design implementation, the supplier implements the design reviewed and analyzed by the acquirer by developing product components, integrating those components, conducting unit and integration testing of the product, and developing end-user documentation.

A successful analysis of the supplier's implementation is predicated on the acquirer's determination that the requirements are fully met in the final production configuration, that the production capability forms a satisfactory basis for proceeding into pilots or full-rate production, and that the product is ready to be brought into the acquirer environment for further integration and acceptance testing.

Examples of success criteria for the analysis of the supplier's design implementation include the following:

- The product baseline enables hardware fabrication and software coding to proceed with proper configuration management.
- Adequate production processes and measures are in place for the project to succeed.
- Risks are managed effectively.
- The detailed design is producible within the production budget.

The acquirer may require delivery of verification results from the supplier of the technical solution, as applicable. The suppliers may conduct verifications in an iterative fashion, concurrently with the acquirer's technical analyses, or the supplier may be required to conduct follow-on verifications of technical solutions.

Typical expectations for verification addressed by the supplier agreement include the following:

- List of deliverables and other work products that must be verified by the supplier
- Applicable standards, procedures, methods, tools
- Criteria for verification of supplier work products
- Measurements to be collected and provided by the supplier with regard to verification activities
- Reviews of supplier verification results and corrective actions with the acquirer

Examples of considerations for follow-on verifications of technical solutions include the following:

- During the production stage of the project, there are changes in either materials or manufacturing processes.
- Production start-up or re-start occurs after a significant shutdown period.
- Production starts-up with a new supplier.
- A manufacturing site has relocated.

The acquirer should also confirm that sufficient end-user documentation has been developed and is in alignment with the tested implementation. The supplier may develop preliminary versions of the installation, operations, and maintenance documentation in early phases of the project lifecycle for review by acquirer and relevant stakeholders.

Typical Work Products

1. Record of analysis
2. Results of analysis

Typical Supplier Deliverables

1. Alternative solutions
2. Product architecture
3. Product component designs
4. Unit and integration test results
5. Verification results

Subpractices

1. Confirm that the selected technical solution adheres to applicable standards and criteria.
2. Confirm that the selected technical solution adheres to allocated requirements.
3. Use analysis results to compare actual performance measurements to specified thresholds of technical performance measures.

Refer to the Measurement and Analysis process area for more information about technical performance measures.

4. Conduct technical interchange meetings as necessary.

Technical interchange meetings are scheduled meetings between the supplier and acquirer to discuss technical progress. These meetings are less formal than the event-driven technical reviews in the next specific practice.

5. Confirm that the selected technical solution is sufficiently analyzed and meets entrance criteria to begin technical review.
6. Review critical verification results and data from verifications conducted by the supplier.

SP 1.3 Conduct Technical Reviews

Conduct technical reviews with the supplier as defined in the supplier agreement.

Technical reviews are used by the acquirer to confirm that products and services being developed or produced by suppliers meet user needs and requirements.

Technical reviews should have the following characteristics:

- Conducted when the technical solution under development satisfies review entry criteria (i.e., event driven, not schedule driven)
- At a minimum, conducted at the transition from one acquisition phase to the next and at major transition points of technical effort
- Have their processes and requirements addressed in and required by the supplier agreement

Typically, the project's technical plan (e.g., the systems engineering management plan) documents the timing, conduct, entrance criteria, and success or exit criteria used for technical reviews.

Refer to the Project Planning process area for more information about planning the technical aspects of the project.

Technical reviews typically include the following activities:

- Reviewing the supplier's technical activities and verifying that the supplier's interpretation and implementation of requirements are consistent with the acquirer's interpretation
- Ensuring that technical commitments are being met and that technical issues are communicated and resolved in a timely manner
- Obtaining technical information about the supplier's products
- Providing the supplier with insight into customer and end user expectations and requirements
- Providing appropriate technical information and support to the supplier

Examples of technical reviews that can be conducted include the following:

- Initial Technical Review (ITR)
- Alternative System Review (ASR)
- Integrated Baseline Review (IBR)
- Technology Readiness Assessment (TRA)
- System Requirements Review (SRR)
- System Functional Review (SFR)
- Preliminary Design Review (PDR)
- Critical Design Review (CDR)
- Test Readiness Review (TRR)
- System Verification Review (SVR)
- Production Readiness Review (PRR)
- Operational Test Readiness Review (OTRR)
- Physical Configuration Audit (PCA)

Typical Work Products

1. Review schedule
2. Entry and exit criteria
3. Review results
4. Documented issues (e.g., issues with customer requirements, product and product component requirements, product architecture, and product design)

Typical Supplier Deliverables

1. Progress reports and process, product, and service level measurements
2. Technical performance measurements
3. Review materials and reports
4. Action items tracked to closure
5. Documentation of product and document deliveries

Subpractices

1. Identify participants for the technical review.
2. Conduct the technical review.
3. Analyze and record results of the review.

4. Use the results of technical reviews to improve the supplier's technical solution.

The results of some reviews may require changes to the supplier agreement.

*Refer to the *Solicitation and Supplier Agreement Development* process area for more information about establishing and maintaining the supplier agreement.*

SG 2 Perform Interface Management

Selected interfaces are managed.

Many integration and transition problems arise from unknown or uncontrolled aspects of both internal and external interfaces. Effective management of interface requirements, specifications, and designs helps to ensure implemented interfaces are complete and compatible.

The supplier is responsible for managing the interfaces of the product or service it is developing. However, the acquirer identifies those interfaces, particularly external interfaces, that it will manage as well.

SP 2.1 Select Interfaces to Manage

Select interfaces to manage.

The interfaces considered for selection include all interfaces with other products and services in the operations and support environment as well as environments for verification and validation and services that support those environments. The acquirer should review all supplier interface data for completeness to substantiate the complete coverage of all interfaces when making the selection.

Typical Work Products

1. Criteria to be used in selecting acquirer-managed interfaces
2. Categories of interfaces
3. List of interfaces per category

Typical Supplier Deliverables

1. Interface description documents
2. Categories of interfaces
3. List of interfaces per category
4. Mapping of interfaces to product components and the product integration environment
5. Interface design specifications
6. Interface control documents

7. Interface specification criteria

Subpractices

1. Select the criteria to be used for determining which interfaces the acquirer should manage.

Refer to the Decision Analysis and Resolution process area for more information about establishing evaluation criteria used in making decisions.

2. Identify interfaces that are candidates for acquirer management.

Example criteria for interfaces that typically are the focus of the acquirer's management include the following:

- The interface spans organizational boundaries.
- The interface is mission critical.
- The interface is difficult or complex to manage.
- Capability, interoperability, or efficiency issues are associated with the interface.
- The interface impacts multiple acquisition projects.

3. Review identified interfaces against the selection criteria.

4. Include acquirer-managed interfaces in the project plan.

SP 2.2

Manage Selected Interfaces

Manage selected interfaces.

Managing interfaces includes the maintenance of the consistency of the interfaces throughout the life of the product and the resolution of conflict, noncompliance, and change issues. In a system of systems environment, the management of interfaces between products or services acquired from suppliers and other systems within the system of systems is critical for success of the project.

Refer to the Acquisition Requirements Development process area for more information about establishing and maintaining interface requirements.

Refer to the Requirements Management process area for more information about managing changes to interface requirements.

Refer to the Configuration Management process area for more information about managing changes to interface descriptions (i.e., specifications) as configuration items so that stakeholders can be made aware of the current state of the interfaces.

Interface changes are documented, maintained, and readily accessible.

Typical Work Products

1. Table of relationships among the supplier's product or service and the external environment
2. Updated interface description or agreement

Typical Supplier Deliverables

1. Table of relationships among the product components and the external environment (e.g., main power supply, fastening product, and computer bus system)
2. Reports from interface control working group meetings
3. Action items for updating interfaces
4. Application program interface (API)

Subpractices

1. Review and analyze selected interface definitions and designs.
2. Confirm that interface descriptions adhere to allocated requirements.
3. Confirm the compatibility of selected interfaces throughout the life of the product or service.

Confirm that interface descriptions adhere to applicable standards, criteria, and interface requirements between the supplier's product and acquirer's intended environment.

4. Verify that interfaces have been sufficiently tested by the supplier
5. Verify that issues identified during testing have been resolved appropriately, with product revisions, if necessary.
6. Resolve conflict, noncompliance, and change issues for the selected interfaces.
7. Periodically review the adequacy of interface descriptions.

Once established, interface descriptions must be periodically reviewed to ensure there is no deviation between existing descriptions and the products being developed, processed, produced, or bought.

The interface descriptions should be reviewed with relevant stakeholders to avoid misinterpretations, reduce delays, and prevent the development of interfaces that do not work properly.

ACQUISITION VALIDATION

An Acquisition Process Area at Maturity Level 3

Purpose

The purpose of Acquisition Validation (AVAL) is to demonstrate that an acquired product or service fulfills its intended use when placed in its intended environment.

Introductory Notes

Validation demonstrates that the acquired product or service, as provided, will fulfill its intended use. In other words, validation ensures that the acquired product or service meets stakeholders' needs and customer requirements.

Validation activities are performed early and incrementally throughout the project lifecycle. These activities can be applied to all aspects of the product and its components in any of their intended environments, such as operations, training, manufacturing, maintenance, and support services. (Throughout the process areas, where we use the phrase *product and product component*, the intended meaning encompasses services and their components.)

The product or product components that are selected to be validated by the acquirer vary depending on project attributes. Methods used to conduct validation also can be applied to selected acquirer work products (e.g., customer requirements) and supplier deliverables (e.g., prototypes, simulations, and demonstrations). Method selection is based on which methods best predict how well the acquired product or service will satisfy stakeholder needs.

Whenever possible, validation should be conducted using the product or product component operating in its intended environment. Either the entire environment or part of it can be used.

When validation issues are identified, these issues are referred to processes associated with the Acquisition Requirements Development or Project Monitoring and Control process areas for resolution.

The specific practices of this process area build on each other in the following way:

- The Select Products for Validation specific practice enables the identification of the product or product component to be validated and methods to be used to perform the validation.

- The Establish the Validation Environment specific practice enables the determination of the environment to be used to carry out the validation.
- The Establish Validation Procedures and Criteria specific practice enables the development of validation procedures and criteria that are aligned with the characteristics of selected products, customer constraints on validation, methods, and the validation environment.
- The Perform Validation specific practice enables the performance of validation according to methods, procedures, and criteria.
- The Analyze Validation Results specific practice enables the analysis of validation results against criteria.

Related Process Areas

Refer to the Acquisition Requirements Development process area for more information about requirements validation.

Refer to the Agreement Management process area for more information about accepting the acquired product or service.

Refer to the Acquisition Technical Management process area for more information about evaluating supplier work products.

Specific Goal and Practice Summary

SG 1 Prepare for Validation

- SP 1.1 Select Products for Validation
- SP 1.2 Establish the Validation Environment
- SP 1.3 Establish Validation Procedures and Criteria

SG 2 Validate Selected Products and Product Components

- SP 2.1 Perform Validation
- SP 2.2 Analyze Validation Results

Specific Practices by Goal

SG 1 Prepare for Validation

Preparation for validation is conducted.

Validation preparation activities include selecting products and product components for validation and establishing and maintaining the validation environment, procedures, and criteria. Items selected for validation may include only the product or it may include appropriate levels of product components used to build the product. Any product or product component may be subject to validation, including replacement, maintenance, and training products, to name a few.

The environment required to validate the product or product component is prepared. The environment may be purchased or may be specified, designed, and built. Environments used for verification may be considered in collaboration with the validation environment to reduce cost and improve efficiency or productivity.

Expectations for validation which are typically included in the supplier agreement include the following:

- List of acquired products to be validated by the acquirer before formal acceptance
- List of products to be validated with customers, users, or other stakeholders by the supplier and applicable validation standards, procedures, methods, tools and criteria, if any
- Measurements to be collected and provided by the supplier with regard to validation activities
- Supplier roles in product and product component validation
- Validation environments to be used by the acquirer
- Validation procedures to be developed and criteria to be used for validation

SP 1.1 Select Products for Validation

Select products and product components to be validated and validation methods to be used.

Products and product components are selected for validation based on their relationship to user needs. For each product or product component, the scope of the validation (e.g., operational behavior, maintenance, training, and user interface) should be determined.

Examples of products and product components that can be validated include the following:

- Customer requirements and design constraints
- Acquired products and product components (e.g., system, hardware units, software, service documentation)
- User manuals
- Training materials
- Process documentation

Validation methods should be selected early in the life of the project so they are clearly understood and agreed to by relevant stakeholders.

Validation methods address the development, maintenance, support, and training for the product or product components, as appropriate.

Examples of validation methods include the following:

- Discussions with users, perhaps in the context of a formal review
- Prototype demonstrations
- Functional demonstrations (e.g., system, hardware units, software, service documentation, and user interfaces)
- Pilots of training materials
- Tests of products and product components by end users and other relevant stakeholders

Typical Work Products

1. Lists of products and product components selected for validation
2. Validation methods for each product or product component
3. Requirements for performing validation for each product or product component
4. Validation constraints for each product or product component

Subpractices

1. Identify the key principles, features, and phases for product or product component validation throughout the life of the project.
2. Determine the customer requirements to be validated.

The product or product component must be maintainable and supportable in its intended operational environment. This specific practice also addresses the actual maintenance, training, and support services that may be delivered with the product.

3. Select the product and product components to be validated.
4. Select the evaluation methods for product or product component validation.
5. Review the validation selection, constraints, and methods with relevant stakeholders.

SP 1.2

Establish the Validation Environment

Establish and maintain the environment needed to support validation.

The requirements for the validation environment are driven by the product or service selected, type of work products (e.g., design, prototype, and final version), and validation methods. These selections may yield requirements for the purchase or development of equipment, software, or other resources. The validation environment may include the reuse of existing resources. In this case, arrangements for the use of these resources must be made.

Example types of elements in a validation environment include the following:

- Test tools interfaced with the product being validated (e.g., scope, electronic devices, and probes)
- Temporary embedded test software
- Recording tools for dump or further analysis and replay
- Simulated subsystems or components (e.g., software, electronics, or mechanics)
- Simulated interfaced systems (e.g., a dummy warship for testing a naval radar)
- Real interfaced systems (e.g., aircraft for testing a radar with trajectory tracking facilities)
- Facilities and customer-supplied products
- Skilled people to operate or use all the preceding elements
- Dedicated computing or network test environment (e.g., pseudo-operational telecommunications-network test bed or facility with actual trunks, switches, and systems established for realistic integration and validation trials)

Early selection of products or product components to be validated, work products to be used in validation, and validation methods is needed to ensure that the validation environment will be available when necessary.

The validation environment should be carefully controlled to provide for replication, results analysis, and revalidation of problem areas.

Typical Work Products

1. Validation environment

Subpractices

1. Identify requirements for the validation environment.
2. Identify customer-supplied products.
3. Identify reuse items.

4. Identify validation equipment and tools.
5. Identify validation resources that are available for reuse and modification.
6. Plan the availability of resources in detail.

SP 1.3 Establish Validation Procedures and Criteria

Establish and maintain procedures and criteria for validation.

Validation procedures and criteria are defined to ensure the product or product component will fulfill its intended use when placed in its intended environment. Acceptance test cases and procedures may be used for validation procedures.

The validation procedures and criteria include validation of maintenance, training, and support services.

These procedures also address the validation of requirements and the acquired product or service throughout the project lifecycle. Typically, formal acceptance testing procedures and criteria are established to ensure the delivered product or service meets stakeholder needs before it is deployed in the intended environment.

The validation procedures and criteria applicable to the supplier are typically referenced in the solicitation package and supplier agreement.

Examples of sources for validation criteria include the following:

- Business process descriptions
- Customer requirements
- Customer acceptance criteria
- Standards

Typical Work Products

1. Validation procedures
2. Validation criteria
3. Test and evaluation procedures for maintenance, training, and support

Subpractices

1. Review the requirements to ensure that issues affecting validation of the acquired product or service are identified and resolved.
2. Document the environment, operational scenario, procedures, inputs, outputs, and criteria for the validation of the acquired product or service.

3. Assess the product or service as it matures in the context of the validation environment to identify validation issues.

SG 2 Validate Selected Products and Product Components

Selected products and product components are validated to ensure they are suitable for use in their intended operating environment.

The validation methods, procedures, criteria, and the environment are used to validate the selected products and product components and associated maintenance, training, and support services. Validation activities are performed throughout the project lifecycle.

Validation activities are performed by the acquirer, the supplier, or both parties in accordance with the supplier agreement.

SP 2.1 Perform Validation

Perform validation on selected products and product components.

To be acceptable to stakeholders, a product or product component must perform as expected in its intended operational environment.

Validation activities are performed and the resulting data are collected according to established methods, procedures, and criteria.

The as-run validation procedures should be documented and the deviations occurring during the execution should be noted, as appropriate.

Typical Work Products

1. Validation reports
2. Validation results
3. Validation cross-reference matrix
4. As-run procedures log
5. Operational demonstrations

SP 2.2 Analyze Validation Results

Analyze results of validation activities.

The data resulting from validation tests, inspections, demonstrations, or evaluations are analyzed against defined validation criteria. Analysis reports indicate whether needs were met. In the case of deficiencies, these reports document the degree of success or failure and categorize probable causes of failure. The collected test, inspection, or review results are compared with established acceptance criteria to determine whether to proceed or to address requirements or design issues with the supplier.

Analysis reports or as-run validation documentation may also indicate that bad test results are due to a validation procedure problem or a validation environment problem.

Typical Work Products

1. Validation deficiency reports
2. Validation issues
3. Procedure change request

Subpractices

1. Compare actual results to expected results.
2. Based on the established validation criteria, identify products and product components that do not perform suitably in their intended operating environments, or identify problems with methods, criteria, or the environment.
3. Analyze validation data for defects.
4. Record results of the analysis and identify issues.
5. Use validation results to compare actual measurements and performance to the intended use or operational need.
6. Identify, document, and track action items to closure for work products that do not pass their validation.

Refer to the Project Monitoring and Control process area for more information about tracking action items.

ACQUISITION VERIFICATION

An Acquisition Process Area at Maturity Level 3

Purpose

The purpose of Acquisition Verification (AVER) is to ensure that selected work products meet their specified requirements.

Introductory Notes

Acquisition verification addresses whether acquirer work products properly reflect specified requirements.

The Acquisition Verification process area involves the following activities:

- Preparing for verification
- Performing verification
- Identifying corrective action

Verification is inherently an incremental process because it occurs throughout the acquisition of the product or service, beginning with verification of requirements and plans, progressing through the verification of evolving work products such as design and test results, and culminating in the verification of the completed product.

The specific practices of this process area build on each other in the following way:

- The Select Work Products for Verification specific practice enables the identification of work products to be verified, methods to be used to perform the verification, and documented requirements to be satisfied by each selected work product.
- The Establish the Verification Environment specific practice enables the selection or creation of the environment to be used to carry out the verification.
- The Establish Verification Procedures and Criteria specific practice enables the development of verification procedures and criteria that are aligned with selected work products, requirements, methods, and characteristics of the verification environment.
- The Prepare for Peer Reviews, Conduct Peer Reviews, and Analyze Peer Review Data specific practices enable the performance of peer reviews, an important type of verification that is a proven mechanism for effective defect removal.

- The Perform Verification specific practice enables the conduct of verification according to available methods, procedures, and criteria.
- The Analyze Verification Results specific practice enables analysis of verification results against established criteria.

Related Process Areas

Refer to the Acquisition Validation process area for more information about confirming that a product or product component fulfills its intended use when placed in its intended environment.

Refer to the Acquisition Requirements Development process area for more information about generating and developing customer and contractual requirements.

Refer to the Acquisition Technical Management process area for more information about evaluating supplier work products.

Refer to the Requirements Management process area for more information about managing requirements.

Specific Goal and Practice Summary

SG 1 Prepare for Verification

- SP 1.1 Select Work Products for Verification
- SP 1.2 Establish the Verification Environment
- SP 1.3 Establish Verification Procedures and Criteria

SG 2 Perform Peer Reviews

- SP 2.1 Prepare for Peer Reviews
- SP 2.2 Conduct Peer Reviews
- SP 2.3 Analyze Peer Review Data

SG 3 Verify Selected Work Products

- SP 3.1 Perform Verification
- SP 3.2 Analyze Verification Results

Specific Practices by Goal

SG 1 Prepare for Verification

Preparation for verification is conducted.

Up-front preparation is necessary to ensure that verification provisions are embedded in contractual requirements, constraints, plans, and schedules. Verification includes the selection, inspection, testing, analysis, and demonstration of acquirer work products.

Verification methods include but are not limited to inspections, peer reviews, audits, walkthroughs, analyses, simulations, testing, and demonstrations. Practices related to peer reviews as a verification method are included in specific goal 2.

Preparation for verification includes the definition of support tools, test equipment and software, simulations, prototypes, and facilities.

SP 1.1

Select Work Products for Verification

Select work products to be verified and verification methods to be used.

Acquirer work products are selected based on their contribution to meeting project objectives and requirements, and to addressing project risks.

Typical verification activities include the review of the solicitation package, supplier agreements and plans, requirements documents, design constraints developed by the acquirer, and other acquirer-developed work products.

Selection of verification methods typically begins with the definition of requirements to ensure that the requirements are verifiable. Re-verification should be addressed by verification methods to ensure that rework performed on work products does not cause unintended defects. Suppliers should be involved in this selection to ensure that the project's methods are appropriate for the supplier's environment.

Typical Work Products

1. Lists of work products selected for verification
2. Verification methods for each selected work product

Subpractices

1. Identify acquirer work products for verification.
2. Identify requirements to be satisfied by each selected work product.

A traceability matrix is a useful tool for identifying requirements for each selected work product, as it typically includes information that relates requirements to work products. When identifying requirements for each selected work product, consult the traceability matrix maintained as part of managing requirements for the project.

Refer to the Maintain Bidirectional Traceability of Requirements specific practice in the Requirements Management process area for more information about tracing requirements to work products.

3. Identify verification methods available for use.
4. Define verification methods to be used for each selected work product.
5. Identify verification activities and methods to be used in the project plan.

Refer to the Project Planning process area for more information about coordinating with project planning.

SP 1.2 Establish the Verification Environment

Establish and maintain the environment needed to support verification.

An environment must be established to enable verification to take place. The type of environment required depends on the work products selected for verification and the verification methods used. A peer review may require little more than a package of materials, reviewers, and a room. A product test may require simulators, emulators, scenario generators, data reduction tools, environmental controls, and interfaces with other systems.

The verification environment may be acquired, developed, reused, modified, or a combination of these, depending on the needs of the project.

Typical Work Products

1. Verification environment

Subpractices

1. Identify verification environment requirements.
2. Identify verification resources that are available for reuse or modification.
3. Identify verification equipment and tools.
4. Acquire verification support equipment and an environment (e.g., test equipment and software).

SP 1.3 Establish Verification Procedures and Criteria

Establish and maintain verification procedures and criteria for the selected work products.

Verification criteria are defined to ensure that work products meet their requirements.

Examples of sources for verification criteria include the following:

- Standards
- Organizational policies
- Types of work products
- Proposals and agreements

Typical Work Products

1. Verification procedures
2. Verification criteria

Subpractices

1. Generate a set of comprehensive, integrated verification procedures for work products and commercial off-the-shelf products, as necessary.
2. Develop and refine verification criteria as necessary.
3. Identify the expected results, tolerances allowed, and other criteria for satisfying the requirements.
4. Identify equipment and environmental components needed to support verification.

SG 2 Perform Peer Reviews

Peer reviews are performed on selected work products.

Peer reviews are an important part of verification and are a proven mechanism for effective defect removal. An important corollary is to develop an understanding of work products and the processes that produced them to help prevent defects and identify opportunities.

Peer reviews are applied to acquirer-developed work products. These reviews involve a methodical examination of work products by the acquirer's peers to identify defects for removal and to recommend other changes that are needed. Example work products to be peer reviewed include the solicitation package and the supplier agreement.

SP 2.1 Prepare for Peer Reviews

Prepare for peer reviews of selected work products.

Preparation activities for peer reviews typically include identifying the staff to be invited to participate in the peer review of each work product; identifying key reviewers who must participate in the peer review; preparing and updating materials to be used during peer reviews, such as checklists and review criteria; and scheduling peer reviews.

Typical Work Products

1. Peer review schedule
2. Selected work products to be reviewed

Subpractices

1. Determine the type of peer review to be conducted.

2. Establish and maintain checklists to ensure that work products are reviewed consistently.
3. Distribute the work product to be reviewed and related information to participants early enough to enable them to adequately prepare for the peer review.
4. Assign roles for the peer review, as appropriate.

SP 2.2 Conduct Peer Reviews

Conduct peer reviews of selected work products and identify issues resulting from these reviews.

One of the purposes of conducting a peer review is to find and remove defects early. Peer reviews are performed incrementally as work products are being developed. These reviews are structured and are not management reviews.

Typical Work Products

1. Peer review results
2. Peer review issues
3. Peer review data

Subpractices

1. Perform the assigned roles in the peer review.
2. Identify and document defects and other issues in the work product.
3. Record results of the peer review, including action items.
4. Collect peer review data.

Refer to the Measurement and Analysis process area for more information about data collection.

5. Identify action items and communicate issues to relevant stakeholders.
6. Conduct an additional peer review if needed.

SP 2.3 Analyze Peer Review Data

Analyze data about the preparation, conduct, and results of the peer reviews.

Refer to the Measurement and Analysis process area for more information about obtaining and analyzing data.

Typical Work Products

1. Peer review data
2. Peer review action items

Subpractices

1. Record data related to the preparation, conduct, and results of peer reviews.
2. Analyze the peer review data.

SG 3 Verify Selected Work Products

Selected work products are verified against their specified requirements.

Verification methods, procedures, criteria and the environment are used to verify selected work products and associated maintenance, training, and support services. Verification activities should be performed throughout the project lifecycle. Practices related to peer reviews as a verification method are included in specific goal 2.

SP 3.1 Perform Verification

Perform verification on selected work products.

Verifying work products incrementally promotes early detection of problems and can result in the early removal of defects. The results of verification save the considerable cost of fault isolation and rework associated with troubleshooting problems.

Typical Work Products

1. Verification results
2. Verification reports
3. Demonstrations
4. As-run procedures log

Subpractices

1. Perform the verification of selected work products against their requirements.
2. Record the results of verification activities.
3. Identify action items resulting from the verification of work products.
4. Document the “as-run” verification method and deviations from available methods and procedures discovered during its performance.

SP 3.2 Analyze Verification Results

Analyze results of all verification activities.

Actual results must be compared to established verification criteria to determine acceptability.

The results of the analysis of verification results are recorded as evidence that verification was conducted. The acquirer might consult supplier work product verification results and reports to conduct verification activities of acquirer work products.

Refer to the Acquisition Technical Management process area for more information about evaluating supplier work products and reviewing verification results.

For each work product, all available verification results are incrementally analyzed and corrective actions are initiated to ensure that documented requirements have been met. Corrective actions are typically integrated into project monitoring activities. Since a peer review is one of several verification methods, peer review data should be included in this analysis activity to ensure that verification results are analyzed sufficiently.

Analysis reports or “as-run” method documentation may also indicate that bad verification results are due to method problems, criteria problems, or a verification environment problem.

Refer to the Project Monitoring and Control process area for more information about corrective actions.

Typical Work Products

1. Analysis report (e.g., statistics on performance, causal analysis of nonconformances, comparison of the behavior between the real product and models, and trends)
2. Trouble reports
3. Change requests for verification methods, criteria, and the environment

Typical Supplier Deliverables

1. Verification results
2. Verification reports

Subpractices

1. Compare actual results to expected results.
2. Based on the established verification criteria, identify products that do not meet their requirements or identify problems with methods, procedures, criteria, and the verification environment.
3. Analyze the defect data.
4. Record all results of the analysis in a report.
5. Provide information on how defects can be resolved (including verification methods, criteria, and verification environment) and formalize it in a plan.

CAUSAL ANALYSIS AND RESOLUTION

A Support Process Area at Maturity Level 5

Purpose

The purpose of Causal Analysis and Resolution (CAR) is to identify causes of defects and other problems and take action to prevent them from occurring in the future.

Introductory Notes

The Causal Analysis and Resolution process area involves the following activities:

- Identifying and analyzing causes of defects and other problems
- Taking actions to remove causes and prevent the occurrence of those types of defects and problems in the future

Causal analysis and resolution improves quality and productivity by preventing the introduction of defects into a product. Reliance on detecting defects after they have been introduced is not cost effective. It is more effective to prevent defects from being introduced by integrating causal analysis and resolution activities into each phase of the project.

Since similar defects and problems may have been previously encountered on other projects or in earlier phases or tasks of the current project, causal analysis and resolution activities are a mechanism for communicating lessons learned among projects.

Types of defects and other problems encountered are analyzed to identify trends. Based on an understanding of the defined process and how it is implemented, root causes of defects and future implications of defects are determined.

Causal analysis may also be performed on problems unrelated to defects. For example, causal analysis may be used to improve coordination and cycle time with one supplier or multiple suppliers.

When it is impractical to perform causal analysis on all defects, defect targets are selected by tradeoffs on estimated investments and estimated returns of quality, productivity, and cycle time.

A measurement process should already be in place. Already defined measures can be used, though in some instances new measures may be needed to analyze the effects of the process change.

Refer to the Measurement and Analysis process area for more information about establishing objectives for measurement and analysis, specifying measures and analyses to be performed, obtaining and analyzing measures, and reporting results.

Causal Analysis and Resolution activities provide a mechanism for projects to evaluate their processes at the local level and look for improvements that can be implemented.

Causal Analysis and Resolution activities also include the evaluation of acquirer processes that interface with supplier processes, as appropriate. A jointly-performed causal analysis may lead to such improvement actions as the supplier improving its processes to more effectively execute in the context of the project or the acquirer improving its supplier interfaces.

When improvements are judged to be effective, the information is extended to the organizational level.

Refer to the Organizational Innovation and Deployment process area for more information about improving organizational level processes through proposed improvements and action proposals.

The informative material in this process area is written assuming that the specific practices are applied to a quantitatively managed process. The specific practices of this process area may be applicable, but with reduced value, if this assumption is not met.

See the definitions of “stable process” and “common cause of process variation” in the glossary.

Related Process Areas

Refer to the Quantitative Project Management process area for more information about analyzing process performance and determining process capability.

Refer to the Organizational Innovation and Deployment process area for more information about the selection and deployment of improvements to organizational processes and technologies.

Refer to the Measurement and Analysis process area for more information about establishing objectives for measurement and analysis, specifying the measures and analyses to be performed, obtaining and analyzing measures, and reporting results.

Specific Goal and Practice Summary

SG 1 Determine Causes of Defects

SP 1.1 Select Defect Data for Analysis

SP 1.2 Analyze Causes

SG 2 Address Causes of Defects

SP 2.1 Implement Action Proposals

SP 2.2 Evaluate the Effect of Changes

SP 2.3 Record Data

Specific Practices by Goal

SG 1 Determine Causes of Defects

Root causes of defects and other problems are systematically determined.

A root cause is a source of a defect, such that if it is removed, the defect is decreased or removed.

SP 1.1 Select Defect Data for Analysis

Select defects and other problems for analysis.

Typical Work Products

1. Defect and problem data selected for further analysis

Subpractices

1. Gather relevant defect or problem data.

Examples of relevant defect data include the following:

- Defects reported by the customer
- Defects reported by end users
- Defects reported by the supplier

Examples of relevant problem data include the following:

- Project management problem reports requiring corrective action
- Process capability problems
- Process duration measurements
- Earned value measurements by process (e.g., cost performance index)
- Resource throughput, utilization, or response time measurements

Refer to the Quantitative Project Management process area for more information about statistical management.

2. Determine the defects and other problems to be analyzed further.

When determining which defects to analyze further, consider the impact of the defects, their frequency of occurrence, the similarity between defects, the cost of analysis, the time and resources needed, the safety considerations, etc.

Examples of methods for selecting defects and other problems include the following:

- Pareto analysis
- Histograms
- Process capability analysis

SP 1.2 Analyze Causes

Perform causal analysis of selected defects and other problems and propose actions to address them.

The purpose of this analysis is to develop solutions to identified problems by analyzing relevant data and producing action proposals for implementation.

Typical Work Products

1. Action proposal
2. Root cause analysis results

Typical Supplier Deliverables

1. Root cause analysis results
2. Recommended action proposals

Subpractices

1. Conduct causal analysis with those responsible for performing the task.

Causal analysis is performed, typically in meetings, with those who understand the selected defect or problem under study. Those who have the best understanding of the selected defect are typically those responsible for performing the task.

Examples of when to perform causal analysis include the following:

- When a stable subprocess does not meet its specified quality and process-performance objectives
- When more defects than anticipated escape from earlier phases to the current phase
- When a work product exhibits an unexpected deviation from its requirements

Refer to the Quantitative Project Management process area for more information about achieving the project's quality and process-performance objectives.

2. Analyze selected defects and other problems to determine their root causes.

Depending on the type and number of defects, it may make sense to first group the defects before identifying their root causes.

Examples of methods to determine root causes include the following:

- Cause-and-effect (fishbone) diagrams
- Check sheets

3. Group selected defects and other problems based on their root causes.

Examples of cause groups, or categories, include the following:

- Inadequate training and skills
- Inadequate resource allocation
- Breakdown of communication
- Not accounting for all details of a task
- Making mistakes in manual procedures (e.g., typing)
- Process deficiency
- Incomplete, ambiguous, or unclear contractual requirements
- Ineffective management of changes to the supplier agreement

4. Propose and document actions to be taken to prevent the future occurrence of similar defects or other problems.

Examples of proposed actions include changes to the following:

- The process in question
- Training
- Tools
- Methods
- Communication
- Work products

Examples of actions include the following:

- Providing training in common problems and techniques for preventing them
- Changing a process so that error-prone steps do not occur
- Automating all or part of a process
- Reordering process activities
- Adding process steps to prevent defects, such as task kickoff meetings to review common defects and actions to prevent them

An action proposal usually documents the following:

- Originator of the action proposal
- Description of the problem
- Description of the defect cause
- Defect cause category
- Phase when the problem was introduced
- Phase when the defect was identified
- Description of the action proposal
- Action proposal category

SG 2 Address Causes of Defects

Root causes of defects and other problems are systematically addressed to prevent their future occurrence.

Projects operating according to a well-defined process systematically analyze where in the operation problems still occur and implement process changes to eliminate root causes of selected problems.

SP 2.1 Implement Action Proposals

Implement selected action proposals developed in causal analysis.

Action proposals describe tasks necessary to remove root causes of analyzed defects or problems and avoid their reoccurrence.

Only changes that prove to be of value should be considered for broad implementation.

Typical Work Products

1. Action proposals selected for implementation
2. Improvement proposals

Typical Supplier Deliverables

1. Improvement proposals

Subpractices

1. Analyze action proposals and determine their priorities.

Criteria for prioritizing action proposals include the following:

- Implications of not addressing the defects
- Cost to implement process improvements to prevent the defects
- Expected impact on quality

2. Select action proposals to be implemented.
3. Create action items for implementing the action proposals.

Examples of information provided in an action item include the following:

- Person responsible for implementing it
- Description of the areas affected by it
- People who are to be kept informed of its status
- Next date that status will be reviewed
- Rationale for key decisions
- Description of implementation actions
- Time and cost required to identify the defect and correct it
- Estimated cost of not fixing the problem

To implement action proposals, the following tasks must be done:

- Make assignments
- Coordinate the people doing the work
- Review the results
- Track action items to closure

Experiments may be conducted for particularly complex changes.

Examples of experiments include the following:

- Using a temporarily modified process
- Using a new tool

Action items may be assigned to members of the causal analysis team, members of the project team, or other members of the organization.

4. Identify and remove similar defects that may exist in other processes and work products.
5. Identify and document improvement proposals for the organization's set of standard processes.

Refer to the Organizational Innovation and Deployment process area for more information about the selection and deployment of improvement proposals for the organization's set of standard processes.

SP 2.2 Evaluate the Effect of Changes

Evaluate the effect of changes on process performance.

Refer to the Quantitative Project Management process area for more information about analyzing process performance, stabilizing selected subprocesses, and determining their capability to achieve objectives.

Once the changed process is deployed across the project, the effect of changes must be evaluated to gather evidence that the process change corrected the problem and improved performance.

Typical Work Products

1. Measures of performance and performance change

Typical Supplier Deliverables

1. Base and derived supplier measurements

Subpractices

1. Measure the change in performance of the project's defined process or of subprocesses, as appropriate.

This subpractice determines whether the selected change has positively influenced process performance and by how much.

2. Measure the capability of the project's defined process or of subprocesses, as appropriate.

This subpractice determines whether the selected change has positively influenced the ability of the process to meet its quality and process-performance objectives, as determined by relevant stakeholders.

An example of a change in the capability of the project's defined change management process would be a change in the ability of the process to stay within its process-specification boundaries. This change in capability can be statistically measured by calculating and comparing the range of time taken for processing a change request before and after the improvement has been made.

SP 2.3 Record Data

Record causal analysis and resolution data for use across the project and organization.

Data are recorded so that other projects and organizations can make appropriate process changes and achieve similar results.

Record the following:

- Data on defects and other problems that were analyzed
- Rationale for decisions
- Action proposals from causal analysis meetings

- Action items resulting from action proposals
- Cost of analysis and resolution activities
- Measures of changes to the performance of the defined process resulting from resolutions

Typical Work Products

1. Causal analysis and resolution records

CONFIGURATION MANAGEMENT

A Support Process Area at Maturity Level 2

Purpose

The purpose of Configuration Management (CM) is to establish and maintain the integrity of work products using configuration identification, configuration control, configuration status accounting, and configuration audits.

Introductory Notes

The Configuration Management process area involves the following activities:

- Identifying the configuration of selected work products that compose baselines at given points in time
- Controlling changes to configuration items
- Building or providing specifications to build work products from the configuration management system
- Maintaining the integrity of baselines
- Providing accurate status and current configuration data to developers, end users, and customers

The work products placed under configuration management include the products that are delivered to the customer, designated internal work products, acquired products, tools, and other items used in creating and describing these work products. (See the definition of “configuration management” in the glossary.)

Acquired products may need to be placed under configuration management by both the supplier and the acquirer. Provisions for conducting configuration management should be established in supplier agreements. Methods to ensure that data are complete and consistent should be established and maintained.

The configuration management approach depends on acquisition factors such as acquisition approach, number of suppliers, design responsibility, support concept, and associated costs and risks. In any case, configuration management involves interaction between the acquirer and supplier.

Planning for managing configuration items, including during the transition to operations and support, is addressed as part of project planning and supplier agreement development to avoid unexpected costs for both the acquirer and supplier. Project plans and supplier agreements should make provisions for managing configuration items within and across project teams and the infrastructure required to manage configuration items among the acquirer, supplier, operational users, and other relevant stakeholders.

For example, there are shared responsibilities between the acquirer and supplier for the technical solution. The acquirer maintains configuration control of the contractual requirements and the supplier performs configuration management for the technical solution (e.g., establish and maintain the product baseline).

In this example, the acquirer retains the authority and responsibility for approving design changes that impact the product's ability to meet contractual requirements. The supplier manages other design changes. The acquirer maintains the right to access configuration data at any level required to implement planned or potential design changes and support options. Configuration management of legacy systems should be addressed on a case-by-case basis as design changes are contemplated.

Examples of work products that may be placed under configuration management include the following:

- Plans
- Process descriptions
- Requirements
- Acquisition strategies
- Solicitation packages
- Supplier agreements
- Supplier deliverables

Configuration management of work products may be performed at several levels of granularity. Configuration items can be decomposed into configuration components and configuration units. Only the term *configuration item* is used in this process area. Therefore, in these practices, *configuration item* may be interpreted as *configuration component* or *configuration unit*, as appropriate. (See the definition of "configuration item" in the glossary.)

Baselines provide a stable basis for the continuing evolution of configuration items.

An example of an acquirer's baseline is a collection of acquirer work products such as contractual requirements and acceptance criteria that are related to the product baseline managed by the supplier.

Baselines are added to the configuration management system as they are developed. Changes to baselines and the release of work products built from the configuration management system are systematically controlled and monitored via the configuration control, change management, and configuration auditing functions of configuration management.

This process area applies not only to configuration management on projects but also to configuration management on organizational work products such as standards, procedures, and reuse libraries.

Configuration management is focused on the rigorous control of the managerial and technical aspects of work products, including the delivered system.

This process area covers the practices for performing the configuration management function and is applicable to all work products that are placed under configuration management.

Related Process Areas

Refer to the Agreement Management process area for more information about formal acceptance of supplier deliverables.

Refer to the Project Planning process area for more information about developing plans and work breakdown structures, which may be useful for determining configuration items.

Refer to the Project Monitoring and Control process area for more information about performance analyses and corrective actions.

Specific Goal and Practice Summary

SG 1 Establish Baselines

- SP 1.1 Identify Configuration Items
- SP 1.2 Establish a Configuration Management System
- SP 1.3 Create or Release Baselines

SG 2 Track and Control Changes

- SP 2.1 Track Change Requests
- SP 2.2 Control Configuration Items

SG 3 Establish Integrity

- SP 3.1 Establish Configuration Management Records
- SP 3.2 Perform Configuration Audits

Specific Practices by Goal

SG 1 Establish Baselines

Baselines of identified work products are established.

Specific practices to establish baselines are covered by this specific goal. The specific practices under the Track and Control Changes specific goal serve to maintain the baselines. The specific practices of the Establish Integrity specific goal document and audit the integrity of the baselines.

SP 1.1 Identify Configuration Items

Identify configuration items, components, and related work products to be placed under configuration management.

Configuration identification is the selection, creation, and specification of the following:

- Products delivered to the customer
- Designated internal work products
- Acquired products
- Tools and other capital assets of the project's work environment
- Other items used in creating and describing these work products

Items under configuration management include specifications and interface documents that define requirements for the product. Other documents, such as test results, may also be included, depending on their importance to defining the product.

A *configuration item* is an entity designated for configuration management, which may consist of multiple related work products that form a baseline. This logical grouping provides ease of identification and controlled access. The selection of work products for configuration management should be based on criteria established during planning.

Configuration items may vary widely in complexity, size, and type, from an aircraft to commercial-of-the-shelf software to a test meter or a project plan. Any item required for product support and designated for separate procurement is a configuration item. Acquirer work products provided to suppliers such as solicitation packages and technical standards are typically designated as configuration items.

Typical Work Products

1. Identified configuration items

Subpractices

1. Select configuration items and work products that compose them based on documented criteria.

Example criteria for selecting configuration items at the appropriate work-product level include the following:

- Work products that may be used by two or more groups
- Work products that are expected to change over time either because of errors or changes in requirements
- Work products that are dependent on each other (i.e., a change in one mandates a change in the others)
- Work products critical to project success

Examples of acquirer work products and supplier deliverables that may be part of a configuration item include the following:

- Process descriptions
- Requirements
- Acceptance criteria
- Supplier project progress and performance reports
- Supplier test results

2. Assign unique identifiers to configuration items.
3. Specify the important characteristics of each configuration item.
4. Specify when each configuration item is placed under configuration management.

Example criteria for determining when to place work products under configuration management include the following:

- Stage of the project lifecycle
- When the acquirer work product is ready for review and approval
- Degree of control desired on the work product
- Cost and schedule limitations
- Customer requirements

5. Identify the owner responsible for each configuration item.

SP 1.2 Establish a Configuration Management System

Establish and maintain a configuration management and change management system for controlling work products.

A configuration management system includes the storage media, procedures, and tools for accessing the system.

A change management system includes the storage media, procedures, and tools for recording and accessing change requests.

The acquirer considers how configuration items are shared between the acquirer and supplier as well as among relevant stakeholders. If the use of an acquirer's configuration management system is extended to a supplier, the acquirer must exercise security and access control procedures. In many cases, leaving acquired configuration items in the physical possession of the supplier and having access to supplier deliverables is an alternative solution. The supplier agreement specifies appropriate acquirer rights to supplier deliverables, in addition to requirements for delivery or access. Supplier work products, whenever they are delivered to the acquirer, are presented in accordance with accepted standards to ensure usability by the acquirer.

Typical Work Products

1. Configuration management system with controlled work products
2. Configuration management system access control procedures
3. Change request database

Subpractices

1. Establish a mechanism to manage multiple levels of control.

The level of control is typically selected based on project objectives, risk, and resources. Levels of control can range from informal control that simply tracks changes made when configuration items are being developed by the acquirer or when supplier work products are delivered or made accessible to the acquirer, to formal configuration control using baselines that can only be changed as part of a formal configuration management process.

2. Store and retrieve configuration items in a configuration management system.
3. Share and transfer configuration items between control levels in the configuration management system.
4. Store and recover archived versions of configuration items.
5. Store, update, and retrieve configuration management records.
6. Create configuration management reports from the configuration management system.
7. Preserve the contents of the configuration management system.

Examples of preservation functions of the configuration management system include the following:

- Backup and restoration of configuration management files
- Archive of configuration management files
- Recovery from configuration management errors

8. Revise the configuration management structure as necessary.

SP 1.3 Create or Release Baselines

Create or release baselines for internal use and for delivery to the customer.

A baseline is a set of specifications or work products that has been formally reviewed and agreed on, that thereafter serves as the basis for further development or delivery, and that can be changed only through change control procedures. A baseline represents the assignment of an identifier to a configuration item or a collection of configuration items and associated entities. As a product evolves, several baselines may be used to control its development and testing.

The acquirer reviews and approves the release of product baselines created by the supplier. The acquirer creates baselines for acquirer work products that describe the project, requirements, funding, schedule, and performance measures and makes a commitment to manage the project to those baselines.

Typical Work Products

1. Baselines
2. Description of baselines

Typical Supplier Deliverables

1. Product baselines
2. Description of product baselines

Subpractices

1. Obtain authorization from the configuration control board (CCB) before creating or releasing baselines of configuration items.
2. Create or release baselines only from configuration items in the configuration management system.
3. Document the set of configuration items that are contained in a baseline.
4. Make the current set of baselines readily available.

SG 2 Track and Control Changes

Changes to the work products under configuration management are tracked and controlled.

The specific practices under this specific goal serve to maintain baselines after they are established by specific practices under the Establish Baselines specific goal.

SP 2.1 Track Change Requests

Track change requests for configuration items.

Change requests address not only new or changed requirements but also failures and defects in work products.

Change requests can be initiated either by the acquirer or supplier. Changes that impact acquirer work products and supplier deliverables as defined in the supplier agreement are handled through the acquirer's configuration management process.

Change requests are analyzed to determine the impact that the change will have on the work product, related work products, the budget, and the schedule.

Typical Work Products

1. Change requests

Typical Supplier Deliverables

1. Change requests

Subpractices

1. Initiate and record change requests in the change request database.
2. Analyze the impact of changes and fixes proposed in change requests.

The acquirer analyzes the impact that submitted change requests may have on supplier agreements.

*Refer to the *Solicitation and Supplier Agreement Development* process area for more information about changing the supplier agreement.*

3. Review change requests to be addressed in the next baseline with relevant stakeholders and get their agreement.

Conduct the change request review with appropriate participants. Record the disposition of each change request and the rationale for the decision, including success criteria, a brief action plan if appropriate, and needs met or unmet by the change. Perform the actions required in the disposition, and report results to relevant stakeholders.

4. Track the status of change requests to closure.

SP 2.2 Control Configuration Items

Control changes to configuration items.

Control is maintained over the configuration of the work product baseline. This control includes tracking the configuration of each configuration item, approving a new configuration if necessary, and updating the baseline.

The acquirer decides which configuration items require version control, or more stringent levels of configuration control, and establishes mechanisms to ensure configuration items are controlled. Although the supplier may manage configuration items on the acquirer's behalf, the acquirer is responsible for approval and control of changes to these configuration items.

Typical Work Products

1. Revision history of configuration items
2. Archives of baselines

Subpractices

1. Control changes to configuration items throughout the life of the product.
2. Obtain appropriate authorization before changed configuration items are entered into the configuration management system.

For example, authorization may come from the CCB, the project manager, or the customer.
3. Check in and check out configuration items in the configuration management system for incorporation of changes in a manner that maintains the correctness and integrity of configuration items.
4. Perform reviews to ensure that changes have not caused unintended effects on the baselines (e.g., ensure that changes have not compromised the safety and/or security of the system).
5. Record changes to configuration items and reasons for changes, as appropriate.

SG 3 Establish Integrity

Integrity of baselines is established and maintained.

The integrity of baselines, established by processes associated with the Establish Baselines specific goal, and maintained by processes associated with the Track and Control Changes specific goal, is addressed by the specific practices under this specific goal.

SP 3.1 Establish Configuration Management Records

Establish and maintain records describing configuration items.

Typical Work Products

1. Revision history of configuration items
2. Change log
3. Change request records
4. Status of configuration items
5. Differences between baselines

Typical Supplier Deliverables

1. Revision history of product and supplier deliverables defined in the supplier agreement

Subpractices

1. Record configuration management actions in sufficient detail so the content and status of each configuration item is known and previous versions can be recovered.
2. Ensure that relevant stakeholders have access to and knowledge of the configuration status of configuration items.
3. Specify the latest version of baselines.
4. Identify the version of configuration items that constitute a particular baseline.
5. Describe differences between successive baselines.
6. Revise the status and history (i.e., changes and other actions) of each configuration item as necessary.

SP 3.2 Perform Configuration Audits

Perform configuration audits to maintain the integrity of configuration baselines.

Configuration audits confirm that the resulting baselines and documentation conform to a specified standard or requirement. Audit results should be recorded, as appropriate. (See the glossary for a definition of “configuration audit.”)

Typical Work Products

1. Configuration audit results
2. Action items

Typical Supplier Deliverables

1. Supplier configuration audit results

Subpractices

1. Assess the integrity of baselines.
2. Confirm that configuration management records correctly identify configuration items.
3. Review the structure and integrity of items in the configuration management system.
4. Confirm the completeness and correctness of items in the configuration management system.

Completeness and correctness of the configuration management system's content is based on requirements as stated in the plan and the disposition of approved change requests.

5. Confirm compliance with applicable configuration management standards and procedures.
6. Track action items from the audit to closure.

DECISION ANALYSIS AND RESOLUTION

A Support Process Area at Maturity Level 3

Purpose

The purpose of Decision Analysis and Resolution (DAR) is to analyze possible decisions using a formal evaluation process that evaluates identified alternatives against established criteria.

Introductory Notes

The Decision Analysis and Resolution process area involves establishing guidelines to determine which issues should be subject to a formal evaluation process and applying formal evaluation processes to these issues.

A formal evaluation process is a structured approach to evaluating alternative solutions against established criteria to determine a recommended solution.

A formal evaluation process involves the following actions:

- Establishing the criteria for evaluating alternatives
- Identifying alternative solutions
- Selecting methods for evaluating alternatives
- Evaluating alternative solutions using established criteria and methods
- Selecting recommended solutions from alternatives based on evaluation criteria

Rather than using the phrase *alternative solutions to address issues* each time, in this process area, one of two shorter phrases are used: *alternative solutions* or *alternatives*.

A repeatable criteria-based decision-making process is especially important, both for making critical decisions that define and guide the acquisition process and later for critical decisions made with the selected supplier. The establishment of a formal process for decision making provides the acquirer with documentation of decision rationale. Such documentation allows criteria for critical decisions to be revisited when changes or technology insertion decisions that impact requirements or other critical project parameters are considered. A formal process also supports the communication of decisions between the acquirer and supplier.

A formal evaluation process reduces the subjective nature of a decision and provides a higher probability of selecting a solution that meets multiple demands of relevant stakeholders.

While the primary application of this process area is to technical concerns, formal evaluation processes can also be applied to many nontechnical issues, particularly when a project is being planned. Issues that have multiple alternative solutions and evaluation criteria lend themselves to a formal evaluation process.

Guidelines are created for deciding when to use formal evaluation processes to address unplanned issues. Guidelines often suggest using formal evaluation processes when issues are associated with medium to high risks or when issues affect the ability to achieve project objectives.

Formal evaluation processes can vary in formality, type of criteria, and methods employed. Less formal decisions can be analyzed in a few hours, use few criteria (e.g., effectiveness and cost to implement), and result in a one- or two-page report. More formal decisions may require separate plans, months of effort, meetings to develop and approve criteria, simulations, prototypes, piloting, and extensive documentation.

Both numeric and non-numeric criteria can be used in a formal evaluation process. Numeric criteria use weights to reflect the relative importance of criteria. Non-numeric criteria use a more subjective ranking scale (e.g., high, medium, or low). More formal decisions may require a full trade study.

A formal evaluation process identifies and evaluates alternative solutions. The eventual selection of a solution may involve iterative activities of identification and evaluation. Portions of identified alternatives may be combined, emerging technologies may change alternatives, and the business situation of suppliers may change during the evaluation period.

A recommended alternative is accompanied by documentation of selected methods, criteria, alternatives, and rationale for the recommendation. The documentation is distributed to relevant stakeholders; it provides a record of the formal evaluation process and rationale, which are useful to other projects that encounter a similar issue.

While some of the decisions made throughout the life of the project involve the use of a formal evaluation process, others do not. As mentioned earlier, guidelines should be established to determine which issues should be subject to a formal evaluation process.

Related Process Areas

Refer to the Project Planning process area for more information about general planning for projects.

Refer to the Integrated Project Management process area for more information about establishing the project's defined process. The project's defined process includes a formal evaluation process for each selected issue and incorporates the use of guidelines for applying a formal evaluation process to unforeseen issues.

Refer to the Risk Management process area for more information about identifying and mitigating risks. A formal evaluation process is often used to address issues with identified medium or high risks. Selected solutions typically affect risk mitigation plans.

Specific Goal and Practice Summary

SG 1 Evaluate Alternatives

- SP 1.1 Establish Guidelines for Decision Analysis
- SP 1.2 Establish Evaluation Criteria
- SP 1.3 Identify Alternative Solutions
- SP 1.4 Select Evaluation Methods
- SP 1.5 Evaluate Alternatives
- SP 1.6 Select Solutions

Specific Practices by Goal

SG 1 Evaluate Alternatives

Decisions are based on an evaluation of alternatives using established criteria.

Issues requiring a formal evaluation process may be identified at any time. The objective should be to identify issues as early as possible to maximize the time available to resolve them.

SP 1.1 Establish Guidelines for Decision Analysis

Establish and maintain guidelines to determine which issues are subject to a formal evaluation process.

Not every decision is significant enough to require a formal evaluation process. The choice between the trivial and the truly important are unclear without explicit guidance. Whether a decision is significant or not is dependent on the project and circumstances and is determined by established guidelines.

Typical guidelines for determining when to require a formal evaluation process include the following:

- A decision is directly related to topics that are medium or high risk.
- A decision is related to changing work products under configuration management.
- A decision would cause schedule delays over a certain percentage or amount of time.
- A decision affects the ability of the project to achieve its objectives.
- The costs of the formal evaluation process are reasonable when compared to the decision's impact.
- A legal obligation exists during a solicitation.
- There is a risk that the decision will have a significant adverse effect on cost, quality, resources, or schedule.
- Legal or supplier agreement issues must be resolved.

Refer to the Risk Management process area for more information about determining which issues are medium or high risk.

Examples of when to use a formal evaluation process include the following:

- On decisions to trade off performance, cost, and schedule requirements during an acquisition
- On selecting, terminating, or renewing suppliers
- On selecting training for project personnel
- On selecting a testing environment to be used for product validation
- On determining the items to be selected for reuse in related projects
- On selecting an approach for ongoing support (e.g., disaster recovery, service levels)

Typical Work Products

1. Guidelines for when to apply a formal evaluation process

Subpractices

1. Establish guidelines for when to use a formal evaluation process.
2. Incorporate the use of guidelines into the defined process as appropriate.

Refer to the Integrated Project Management process area for more information about establishing the project's defined process.

SP 1.2 Establish Evaluation Criteria

Establish and maintain criteria for evaluating alternatives, and the relative ranking of these criteria.

Evaluation criteria provide the basis for evaluating alternative solutions. Criteria are ranked so that the highest ranked criteria exert the most influence on the evaluation.

This process area is referenced by many other process areas in the model, and there are many contexts in which a formal evaluation process can be used. Therefore, in some situations you may find that criteria have already been defined as part of another process. This specific practice does not suggest that a second development of criteria be conducted.

Document the evaluation criteria to minimize the possibility that decisions will be second-guessed or that the reason for making the decision will be forgotten. Decisions based on criteria that are explicitly defined and established remove barriers to stakeholder buy-in.

Typical Work Products

1. Documented evaluation criteria
2. Rankings of criteria importance

Subpractices

1. Define the criteria for evaluating alternative solutions.

Criteria should be traceable to requirements, scenarios, business case assumptions, business objectives, or other documented sources.

Types of criteria to consider include the following:

- Technology limitations
- Environmental impact
- Risks
- Total ownership and lifecycle costs

2. Define the range and scale for ranking the evaluation criteria.

Scales of relative importance for evaluation criteria can be established with non-numeric values or with formulas that relate the evaluation parameter to a numeric weight.

3. Rank the criteria.
4. Assess the criteria and their relative importance.
5. Evolve the evaluation criteria to improve their validity.

6. Document the rationale for the selection and rejection of evaluation criteria.

SP 1.3 Identify Alternative Solutions

Identify alternative solutions to address issues.

A wider range of alternatives can surface by soliciting as many stakeholders as practical for input. Input from stakeholders with diverse skills and backgrounds can help teams identify and address assumptions, constraints, and biases. Brainstorming sessions may stimulate innovative alternatives through rapid interaction and feedback.

Sufficient candidate solutions may not be furnished for analysis. As the analysis proceeds, other alternatives should be added to the list of potential candidate solutions. The generation and consideration of multiple alternatives early in a decision analysis and resolution process increases the likelihood that an acceptable decision will be made and that consequences of the decision will be understood.

Typical Work Products

1. Identified alternatives

Typical Supplier Deliverables

1. Supplier identified alternatives, if any

Subpractices

1. Perform a literature search.

A literature search can uncover what others have done both inside and outside the organization. Such a search may provide a deeper understanding of the problem, alternatives to consider, barriers to implementation, existing trade studies, and lessons learned from similar decisions.

2. Identify alternatives for consideration in addition to those that may be provided with the issue.

Evaluation criteria are an effective starting point for identifying alternatives. Evaluation criteria identify priorities of relevant stakeholders and the importance of technical, logistical, or other challenges.

Combining key attributes of existing alternatives can generate additional and sometimes stronger alternatives.

Solicit alternatives from relevant stakeholders. Brainstorming sessions, interviews, and working groups can be used effectively to uncover alternatives.

3. Document proposed alternatives.

SP 1.4 Select Evaluation Methods

Select evaluation methods.

Methods for evaluating alternative solutions against established criteria can range from simulations to the use of probabilistic models and decision theory. These methods must be carefully selected. The level of detail of a method should be commensurate with cost, schedule, performance, and risk impacts.

While many problems may require only one evaluation method, some problems may require multiple methods. For instance, simulations may augment a trade study to determine which design alternative best meets a given criterion.

Suppliers competing to develop a technical solution for the acquirer may be directly evaluated in a final competition that involves a performance or functional demonstration of proposed solutions.

Typical Work Products

1. Selected evaluation methods

Subpractices

1. Select methods based on the purpose for analyzing a decision and on the availability of the information used to support the method.

Typical evaluation methods include the following:

- Benchmarking studies
- Cost studies
- Business opportunity studies
- Surveys
- Extrapolations based on field experience and prototypes
- User review and comment
- Judgment provided by an expert or group of experts (e.g., Delphi Method)

2. Select evaluation methods based on their ability to focus on the issues at hand without being overly influenced by side issues.
3. Determine the measures needed to support the evaluation method.

Refer to the Measurement and Analysis process area for more information about specifying measures.

SP 1.5

Evaluate Alternatives

Evaluate alternative solutions using established criteria and methods.

Evaluating alternative solutions involves analysis, discussion, and review. Iterative cycles of analysis are sometimes necessary.

Supporting analyses, experimentation, prototyping, piloting, or simulations may be needed to substantiate scoring and conclusions.

Often, the relative importance of criteria is imprecise and the total effect on a solution is not apparent until after the analysis is performed. In cases where the resulting scores differ by relatively small amounts, the best selection among alternative solutions may not be clear. Challenges to criteria and assumptions should be encouraged.

Typical Work Products

1. Evaluation results

Subpractices

1. Evaluate proposed alternative solutions using the established evaluation criteria and selected methods.
2. Evaluate assumptions related to the evaluation criteria and the evidence that supports the assumptions.
3. Evaluate whether uncertainty in the values for alternative solutions affects the evaluation and address these uncertainties, as appropriate.
4. Perform simulations, modeling, prototypes, and pilots as necessary to exercise the evaluation criteria, methods, and alternative solutions.

Untested criteria, their relative importance, and supporting data or functions may cause the validity of solutions to be questioned. Criteria and their relative priorities and scales can be tested with trial runs against a set of alternatives. These trial runs of a select set of criteria allow for the evaluation of the cumulative impact of criteria on a solution. If trials reveal problems, different criteria or alternatives might be considered to avoid biases.

5. Consider new alternative solutions, criteria, or methods if proposed alternatives do not test well; repeat evaluations until alternatives do test well.

Document the rationale for the addition of new alternatives or methods and changes to criteria, as well as the results of interim evaluations. Determine the scores for each alternative based on criteria evaluations and scoring methods previously determined.

6. Document the results of the evaluation.

SP 1.6 Select Solutions

Select solutions from alternatives based on evaluation criteria.

Selecting solutions involves weighing results from the evaluation of alternatives. Risks associated with the implementation of solutions must be assessed.

Typical Work Products

1. Recommended solutions to address significant issues

Subpractices

1. Assess the risks associated with implementing the recommended solution.

Refer to the Risk Management process area for more information about identifying and managing risks.

2. Document the results and rationale for the recommended solution.

INTEGRATED PROJECT MANAGEMENT

A Project Management Process Area at Maturity Level 3

Purpose

The purpose of Integrated Project Management (IPM) is to establish and manage the project and the involvement of the relevant stakeholders according to an integrated and defined process that is tailored from the organization's set of standard processes.

Introductory Notes

Integrated Project Management involves the following activities:

- Establishing the project's defined process at project startup by tailoring the organization's set of standard processes
- Managing the project using the project's defined process
- Establishing the work environment for the project based on the organization's work environment standards
- Establishing integrated teams that are tasked to accomplish project objectives
- Using and contributing to organizational process assets
- Enabling relevant stakeholders' concerns to be identified, considered, and, when appropriate, addressed during the development of the product
- Ensuring that relevant stakeholders perform their tasks in a coordinated and timely manner (1) to address product and product component requirements, plans, objectives, problems, and risks; (2) to fulfill their commitments; and (3) to identify, track, and resolve coordination issues

The integrated and defined process that is tailored from the organization's set of standard processes is called the project's defined process.

Managing the project's effort, cost, schedule, staffing, risks, and other factors is tied to the tasks of the project's defined process. The implementation and management of the project's defined process are typically described in the project plan. Certain activities may be covered in other plans that affect the project, such as the quality assurance plan, risk management strategy, and the configuration management plan.

Since the defined process for each project is tailored from the organization's set of standard processes, variability among projects is typically reduced and projects can more easily share process assets, data, and lessons learned.

This process area also addresses the coordination of all activities associated with the project such as the following:

- Development activities (e.g., requirements development, design, and verification)
- Service activities (e.g., delivery, help desk, operations, and customer contact)
- Acquisition activities (e.g., solicitation, agreement monitoring, and transition to operations)
- Support activities (e.g., configuration management, documentation, marketing, and training)

The working interfaces and interactions among relevant stakeholders internal and external to the project are planned and managed to ensure the quality and integrity of the entire product. Relevant stakeholders participate, as appropriate, in defining the project's defined process and the project plan. Reviews and exchanges are regularly conducted with relevant stakeholders to ensure that coordination issues receive appropriate attention and everyone involved with the project is appropriately aware of status, plans, and activities. (See the definition of "relevant stakeholder" in the glossary.) In defining the project's defined process, formal interfaces are created as necessary to ensure that appropriate coordination and collaboration occurs.

The acquirer must involve and integrate all relevant acquisition, technical, support, and operational stakeholders. Depending on the scope and risk of the project, coordination efforts with the supplier can be significant.

Formal interfaces among relevant stakeholders take the form of memorandums of understanding, memorandums of agreement, contractual commitments, associated supplier agreements, and similar documents, depending on the nature of the interfaces and involved stakeholders.

This process area applies in any organizational structure, including projects that are structured as line organizations, matrix organizations, or integrated teams. The terminology should be appropriately interpreted for the organizational structure in place.

Related Process Areas

Refer to the Project Planning process area for more information about planning the project, which includes identifying relevant stakeholders and their appropriate involvement in the project.

Refer to the Project Monitoring and Control process area for more information about monitoring and controlling the project.

Refer to the Organizational Process Definition process area for more information about organizational process assets and work environment standards.

Refer to the Measurement and Analysis process area for more information about defining a process for measuring and analyzing processes.

Refer to the Agreement Management process area for more information about managing supplier agreements.

Specific Goal and Practice Summary

SG 1 Use the Project's Defined Process

- SP 1.1 Establish the Project's Defined Process
- SP 1.2 Use Organizational Process Assets for Planning Project Activities
- SP 1.3 Establish the Project's Work Environment
- SP 1.4 Integrate Plans
- SP 1.5 Manage the Project Using Integrated Plans
- SP 1.6 Establish Integrated Teams
- SP 1.7 Contribute to Organizational Process Assets

SG 2 Coordinate and Collaborate with Relevant Stakeholders

- SP 2.1 Manage Stakeholder Involvement
- SP 2.2 Manage Dependencies
- SP 2.3 Resolve Coordination Issues

Specific Practices by Goal

SG 1 Use the Project's Defined Process

The project is conducted using a defined process tailored from the organization's set of standard processes.

The project's defined process must include those processes from the organization's set of standard processes that address all processes necessary to acquire or develop and maintain the product. The product-related lifecycle processes, such as manufacturing and support processes, are developed concurrently with the product.

SP 1.1 Establish the Project's Defined Process

Establish and maintain the project's defined process from project startup through the life of the project.

Refer to the Organizational Process Definition process area for more information about organizational process assets.

Refer to the Organizational Process Focus process area for more information about organizational process needs and objectives and deploying the organization's set of standard processes on projects.

The project's defined process consists of defined processes that form an integrated, coherent lifecycle for the project.

The project's defined process logically sequences acquirer activities and supplier deliverables (as identified in the supplier agreement) to deliver a product that meets the requirements. The acquirer may require the supplier to align selected processes with the acquirer's defined process.

The project's defined process should satisfy the project's contractual requirements, operational needs, opportunities, and constraints. It is designed to provide a best fit for project needs.

A project's defined process is based on the following factors:

- Customer requirements
- Product and product component requirements
- Commitments
- Organizational process needs and objectives
- The organization's set of standard processes and tailoring guidelines
- The operational environment
- The business environment

Establishing the project's defined process at project startup helps to ensure that project staff and stakeholders implement a set of activities needed to efficiently establish an initial set of requirements and plans for the project. As the project progresses, the description of the project's defined process is elaborated and revised to better meet project requirements and the organization's process needs and objectives. Also, as the organization's set of standard processes changes, the project's defined process may need to be revised.

The project's defined process is driven by the acquisition strategy. The acquirer's defined process is affected, for example, by whether the acquisition strategy is to introduce new technology to the organization or to consolidate acquired products or services in use by the acquirer.

Typical Work Products

1. The project's defined process

Typical Supplier Deliverables

1. Tailored supplier processes that interface with the acquirer's defined process

Subpractices

1. Select a lifecycle model from those available in organizational process assets.

Examples of project characteristics that could affect the selection of lifecycle models include the following:

- Size of the project
- Experience and familiarity of staff with implementing the process
- Constraints such as cycle time and acceptable defect levels

2. Select standard processes from the organization's set of standard processes that best fit the needs of the project.

3. Tailor the organization's set of standard processes and other organizational process assets according to tailoring guidelines to produce the project's defined process.

Sometimes the available lifecycle models and standard processes are inadequate to meet project needs. Sometimes the project is unable to produce required work products or measures. In such circumstances, the project must seek approval to deviate from what is required by the organization. Waivers are provided for this purpose.

4. Use other artifacts from the organization's process asset library, as appropriate.

Other artifacts may include the following:

- Lessons-learned documents
- Templates
- Example documents
- Estimating models

5. Document the project's defined process.

6. Conduct peer reviews of the project's defined process.

7. Revise the project's defined process as necessary.

SP 1.2 Use Organizational Process Assets for Planning Project Activities

Use organizational process assets and the measurement repository for estimating and planning project activities.

Refer to the Organizational Process Definition process area for more information about organizational process assets and the organization's measurement repository.

When available, use results of previous planning and execution activities as predictors of the relative scope and risk of the effort being estimated for the current acquisition.

Typical Work Products

1. Project estimates
2. Project plans

Subpractices

1. Use the tasks and work products of the project's defined process as a basis for estimating and planning project activities.

An understanding of the relationships among tasks and work products of the project's defined process and of the roles to be performed by relevant stakeholders is a basis for developing a realistic plan.

2. Use the organization's measurement repository in estimating the project's planning parameters.

This estimate typically includes the following:

- Using appropriate historical data from this project or similar projects
- Accounting for and recording similarities and differences between the current project and those projects whose historical data will be used
- Ensuring historical data are valid
- Recording the reasoning, assumptions, and rationale used to select historical data

SP 1.3 Establish the Project's Work Environment

Establish and maintain the project's work environment based on the organization's work environment standards.

An appropriate work environment for a project comprises an infrastructure of facilities, tools, and equipment that people need to perform their jobs effectively in support of business and project objectives. The work environment and its components are maintained at a level of performance and reliability indicated by organizational work environment standards. As required, the project's work environment or some of its components can be developed internally or acquired from external sources.

The supplier's work environment should be compatible with the acquirer's work environment to enable efficient and effective transfer of work products.

The work environment might encompass environments for both verification and validation or these might be separate environments.

Refer to the Establish Work Environment Standards specific practice in the Organizational Process Definition process area for more information about work environment standards.

Typical Work Products

1. Equipment and tools for the project
2. Installation, operation, and maintenance manuals for the project work environment
3. User surveys and results
4. Usage, performance, and maintenance records
5. Support services for the project's work environment

Subpractices

1. Plan, design, and install a work environment for the project.

The critical aspects of the project work environment are, like any other product, requirements driven. Work environment functionality and operations are explored with the same rigor as is done for any other product development.

It may be necessary to make tradeoffs among performance, costs, and risks. The following are examples of each:

- Performance considerations may include timely interoperable communication, safety, security, and maintainability.
- Costs may include capital outlays, training, a support structure, disassembly and disposal of existing environments, and the operation and maintenance of the environment.
- Risks may include workflow and project disruptions.

Examples of equipment and tools include the following:

- Office software
- Decision support software
- Project management tools
- Requirements management tools and design tools
- Configuration management tools
- Evaluation tools
- Test and evaluation equipment

2. Provide ongoing maintenance and operational support for the project's work environment.

Maintenance and support of the work environment can be accomplished either with capabilities found inside the organization or hired from outside the organization.

Examples of maintenance and support approaches include the following:

- Hiring people to perform maintenance and support
- Training people to perform maintenance and support
- Contracting maintenance and support
- Developing expert users for selected tools

3. Maintain the qualification of components of the project's work environment.

Components include software, databases, hardware, tools, test equipment, and appropriate documentation. Qualification of software includes appropriate certifications. Hardware and test equipment qualification includes calibration and adjustment records and traceability to calibration standards.

4. Periodically review how well the work environment is meeting project needs and supporting collaboration, and take action, as appropriate.

SP 1.4 Integrate Plans

Integrate the project plan and other plans that affect the project to describe the project's defined process.

Refer to the Project Planning process area for more information about establishing and maintaining a project plan.

Refer to the Organizational Process Definition process area for more information about organizational process assets and, in particular, the organization's measurement repository.

Refer to the Organizational Process Focus process area for more information about organizational process needs and objectives.

This specific practice extends the specific practices for establishing and maintaining a project plan to address additional planning activities such as incorporating the project's defined process, coordinating with relevant stakeholders, using organizational process assets, incorporating plans for peer reviews, and establishing objective entry and exit criteria for tasks.

The development of the project plan should account for current and projected needs, objectives, and requirements of the organization, customer, suppliers, and end users, as appropriate.

Typical Work Products

1. Integrated plans

Typical Supplier Deliverables

1. Supplier plans

Subpractices

1. Integrate other plans that affect the project with the project plan.

Other plans that affect the project plan may include the following:

- Quality assurance plans
- Configuration management plans
- Risk management strategy
- Documentation plans

2. Incorporate into the project plan the definitions of measures and measurement activities for managing the project.

Refer to the Measurement and Analysis process area for more information about defining measures and measurement activities and analyzing measurement data.

3. Identify and analyze product and project interface risks.

Refer to the Risk Management process area for more information about identifying and analyzing risks.

4. Schedule tasks in a sequence that accounts for critical development factors and project risks.

Examples of factors considered in scheduling include the following:

- Size and complexity of tasks
- Needs of the customer and end users
- Availability of critical resources
- Availability of key personnel

5. Incorporate plans for performing peer reviews on work products of the project's defined process.
6. Incorporate the training needed to perform the project's defined process in the project's training plans.
7. Establish objective entry and exit criteria to authorize the initiation and completion of tasks described in the work breakdown structure (WBS).

Refer to the Project Planning process area for more information about the WBS.

8. Ensure that the project plan is appropriately compatible with the plans of relevant stakeholders.
9. Identify how conflicts will be resolved that arise among relevant stakeholders.

Refer to the Agreement Management process area for more information about resolving supplier agreement issues.

SP 1.5 Manage the Project Using Integrated Plans

Manage the project using the project plan, other plans that affect the project, and the project's defined process.

Refer to the Organizational Process Definition process area for more information about organizational process assets.

Refer to the Organizational Process Focus process area for more information about organizational process needs and objectives and coordinating process improvement activities with the rest of the organization.

Refer to the Risk Management process area for more information about managing risks.

Refer to the Project Monitoring and Control process area for more information about monitoring and controlling the project.

Typical Work Products

1. Work products created by performing the project's defined process
2. Collected measures (i.e., actuals) and progress records or reports
3. Revised requirements, plans, and commitments
4. Integrated plans

Typical Supplier Deliverables

1. Supplier project progress and performance reports

Subpractices

1. Implement the project's defined process using the organization's process asset library.

This task typically includes the following activities:

- Incorporating artifacts from the organization's process asset library into the project, as appropriate
- Using lessons learned from the organization's process asset library to manage the project

2. Monitor and control the project's activities and work products using the project's defined process, project plan, and other plans that affect the project.

This task typically includes the following activities:

- Using the defined entry and exit criteria to authorize the initiation and determine the completion of tasks
- Monitoring activities that could significantly affect actual values of the project's planning parameters
- Tracking project planning parameters using measurable thresholds that will trigger investigation and appropriate actions
- Monitoring product and project interface risks
- Managing external and internal commitments based on plans for tasks and work products of the project's defined process

An understanding of the relationships among tasks and work products of the project's defined process and of the roles to be performed by relevant stakeholders, along with well-defined control mechanisms (e.g., peer reviews), achieves better visibility into project performance and better control of the project.

3. Obtain and analyze selected measures to manage the project and support organization needs.

Refer to the Measurement and Analysis process area for more information about obtaining and analyzing measures.

4. Periodically review and align the project's performance with current and anticipated needs, objectives, and requirements of the organization, customer, and end users, as appropriate.

This review includes alignment with organizational process needs and objectives.

Examples of actions that achieve alignment include the following:

- Accelerating the schedule, with appropriate adjustments to other planning parameters and project risks
- Changing requirements in response to a change in market opportunities or customer and end-user needs
- Terminating the project

SP 1.6 Establish Integrated Teams

Establish and maintain integrated teams.

The project is managed using integrated teams that reflect the organizational rules and guidelines for team structuring and forming. The project's shared vision is established prior to establishing the team structure, which may be based on the WBS. For small acquirer organizations, the whole organization and relevant external stakeholders can be treated as an integrated team.

Refer to the Establish Rules and Guidelines for Integrated Teams specific practice in the Organizational Process Definition process area for more information about establishing organizational rules and guidelines for structuring and forming integrated teams.

One of the best ways to ensure coordination and collaboration with relevant stakeholders, specific goal 2 of this process area, is to include them on an integrated team. For projects within a system of systems framework, the most important integrated team may be with stakeholders representing other systems.

Typical Work Products

1. Documented shared vision
2. List of team members assigned to each integrated team
3. Integrated team charters
4. Periodic integrated team status reports

Subpractices

1. Establish and maintain the project's shared vision.

When creating a shared vision, it is critical to understand the interfaces between the project and stakeholders external to the project. The vision should be shared among relevant stakeholders through their agreement and commitment.

2. Establish and maintain the integrated team structure.

Cost, schedule, project risks, resources, interfaces, the project's defined process, and organizational guidelines are evaluated to establish the basis for defining integrated teams and their responsibilities, authorities, and interrelationships.
3. Establish and maintain each integrated team.

Establishing and maintaining integrated teams encompasses choosing team leaders and team members and establishing team charters for each team. It also involves providing resources required to accomplish tasks assigned to the team.
4. Periodically evaluate the integrated team structure and composition.

Integrated teams should be monitored to detect malfunctions, mismanaged interfaces, and mismatches of tasks to team members. Take corrective action when performance does not meet expectations.

SP 1.7 Contribute to Organizational Process Assets

Contribute work products, measures, and documented experiences to organizational process assets.

Refer to the Organizational Process Focus process area for more information about process improvement proposals.

Refer to the Organizational Process Definition process area for more information about organizational process assets, the organization's measurement repository, and the organization's process asset library.

This specific practice addresses collecting information from processes in the project's defined process.

Typical Work Products

1. Proposed improvements to organizational process assets
2. Actual process and product measures collected from the project
3. Documentation (e.g., exemplary process descriptions, plans, training modules, checklists, and lessons learned)
4. Process artifacts associated with tailoring and implementing the organization's set of standard processes on the project

Subpractices

1. Propose improvements to organizational process assets.
2. Store process and product measures in the organization's measurement repository.

Refer to the Project Planning process area for more information about recording planning and replanning data.

Refer to the Measurement and Analysis process area for more information about recording measurement data.

3. Submit documentation for possible inclusion in the organization's process asset library.

Examples of documentation include the following:

- Exemplary process descriptions
- Training modules
- Exemplary plans
- Checklists

4. Document lessons learned from the project for inclusion in the organization's process asset library.
5. Provide process artifacts associated with tailoring and implementing the organization's set of standard processes in support of the organization's process monitoring activities.

Refer to the Monitor the Implementation specific practice of the Organizational Process Focus process area for more information about monitoring the implementation of the organization's set of standard processes and use of process assets on all projects.

SG 2 Coordinate and Collaborate with Relevant Stakeholders

Coordination and collaboration between the project and relevant stakeholders are conducted.

SP 2.1 Manage Stakeholder Involvement

Manage the involvement of relevant stakeholders in the project.

Stakeholder involvement is managed according to the project's integrated and defined process.

The supplier agreement provides the basis for managing supplier involvement in the project. Supplier agreements (e.g., interagency and intercompany agreements, memorandums of understanding, memorandums of agreement) that the acquirer makes with stakeholder organizations, which may be product or service providers or recipients, provide the basis for their involvement. These agreements are particularly important when the acquirer's project produces a system that must be integrated into a larger system of systems.

Refer to the Project Planning process area for more information about identifying stakeholders and their appropriate involvement and about establishing and maintaining commitments.

Typical Work Products

1. Agendas and schedules for collaborative activities
2. Documented issues
3. Recommendations for resolving relevant stakeholder issues

Subpractices

1. Coordinate with relevant stakeholders who should participate in project activities.
2. Ensure work products that are produced to satisfy commitments meet the requirements of the recipients.
3. Develop recommendations and coordinate actions to resolve misunderstandings and problems with requirements.

SP 2.2 Manage Dependencies

Participate with relevant stakeholders to identify, negotiate, and track critical dependencies.

Refer to the Project Planning process area for more information about identifying stakeholders and their appropriate involvement and about establishing and maintaining commitments.

Typical Work Products

1. Defects, issues, and action items resulting from reviews with relevant stakeholders
2. Critical dependencies
3. Commitments to address critical dependencies
4. Status of critical dependencies

Typical Supplier Deliverables

1. Status of critical dependencies

Subpractices

1. Conduct reviews with relevant stakeholders.

It is particularly important that acquirers or owners of systems that interact with the project in a system of systems be involved in these reviews to manage critical dependencies these types of systems create.

2. Identify each critical dependency.
3. Establish need dates and plan dates for each critical dependency based on the project schedule.

4. Review and get agreement on commitments to address each critical dependency with those responsible for providing the work product and those receiving the work product.
5. Document critical dependencies and commitments.

The acquirer documents supplier commitments to meet critical dependencies in the supplier agreement. Supplier dependencies and acquirer dependencies are documented in an integrated plan.

6. Track critical dependencies and commitments and take corrective action, as appropriate.

Refer to the Project Monitoring and Control process area for more information about tracking commitments.

Tracking critical dependencies typically includes the following:

- Evaluating the effects of late and early completion for impacts on future activities and milestones
- Resolving actual and potential problems with responsible parties whenever possible
- Escalating to the appropriate party the actual and potential problems not resolvable by the responsible individual or group

SP 2.3 Resolve Coordination Issues

Resolve issues with relevant stakeholders.

Examples of coordination issues include the following:

- Late critical dependencies and commitments
- Product-level problems
- Unavailability of critical resources or personnel
- Incomplete customer requirements
- Unresolved defects

Typical Work Products

1. Relevant stakeholder coordination issues
2. Status of relevant stakeholder coordination issues

Subpractices

1. Identify and document issues.
2. Communicate issues to relevant stakeholders.
3. Resolve issues with relevant stakeholders.

4. Escalate to appropriate managers those issues not resolvable with relevant stakeholders.
5. Track issues to closure.
6. Communicate with relevant stakeholders on the status and resolution of issues.

MEASUREMENT AND ANALYSIS

A Support Process Area at Maturity Level 2

Purpose

The purpose of Measurement and Analysis (MA) is to develop and sustain a measurement capability used to support management information needs.

Introductory Notes

The Measurement and Analysis process area involves the following activities:

- Specifying objectives of measurement and analysis so they are aligned with identified information needs and objectives
- Specifying measures, analysis techniques, and mechanisms for data collection, data storage, reporting, and feedback
- Implementing the collection, storage, analysis, and reporting of data
- Providing objective results that can be used in making informed decisions, and taking appropriate corrective action

The integration of measurement and analysis activities into the processes of the project supports the following:

- Objective planning and estimating
- Tracking actual performance against established plans and objectives
- Identifying and resolving process-related issues
- Providing a basis for incorporating measurement into additional processes in the future

The staff required to implement a measurement capability may or may not be employed in a separate organization-wide program.

Measurement capability may be integrated into individual projects or other organizational functions (e.g., quality assurance).

The initial focus for measurement activities is at the project level. However, a measurement capability may prove useful for addressing organization- and enterprise-wide information needs. To support this capability, measurement activities should support information needs at multiple levels, including the business, organizational unit, and project to minimize re-work as the organization matures.

Projects may choose to store project-specific data and results in a project-specific repository. When data are shared widely across projects, data may reside in the organization's measurement repository.

Measurement and analysis of product components provided by suppliers is essential for effective management of the quality and costs of the project. It is possible, with careful management of supplier agreements, to provide insight into data that support supplier-performance analysis.

The acquirer specifies measures that enable it to gauge its own progress and output, supplier progress and output per contractual requirements, and the status of the evolving products acquired. An acquirer establishes measurement objectives for its activities and work products and supplier activities and deliverables. Measurement objectives are derived from information needs that come from project objectives, organizational objectives, and business needs.

Measurement objectives are used to define measures as well as collection, analysis, storage, and usage procedures for measures. These measures are specified in the project plan. Measures for the supplier, data collection processes and timing, expected analysis, and required storage should be specified in the supplier agreement.

In projects where multiple products are acquired to deliver a capability to the end user or where there are relationships with other projects to acquire joint capabilities, additional measures may be identified to track and achieve interoperability for programmatic, technical, and operational interfaces.

Related Process Areas

Refer to the Project Planning process area for more information about estimating project attributes and other planning information needs.

Refer to the Project Monitoring and Control process area for more information about monitoring project performance information needs.

Refer to the Configuration Management process area for more information about managing measurement work products.

Refer to the Requirements Management process area for more information about maintaining requirements traceability and related information needs.

Refer to the Solicitation and Supplier Agreement Development process area for more information about including supplier measures in the solicitation package and in the supplier agreement.

Refer to the Organizational Process Definition process area for more information about establishing the organization's measurement repository.

Refer to the Quantitative Project Management process area for more information about understanding variation and the appropriate use of statistical analysis techniques.

Specific Goal and Practice Summary

SG 1 Align Measurement and Analysis Activities

- SP 1.1 Establish Measurement Objectives
- SP 1.2 Specify Measures
- SP 1.3 Specify Data Collection and Storage Procedures
- SP 1.4 Specify Analysis Procedures

SG 2 Provide Measurement Results

- SP 2.1 Obtain Measurement Data
- SP 2.2 Analyze Measurement Data
- SP 2.3 Store Data and Results
- SP 2.4 Communicate Results

Specific Practices by Goal

SG 1 Align Measurement and Analysis Activities

Measurement objectives and activities are aligned with identified information needs and objectives.

The specific practices under this specific goal may be addressed concurrently or in any order:

- When establishing measurement objectives, experts often think ahead about necessary criteria for specifying measures and analysis procedures. They also think concurrently about the constraints imposed by data collection and storage procedures.
- Often, it is important to specify the essential analyses to be conducted before attending to details of measurement specification, data collection, or storage.

SP 1.1 Establish Measurement Objectives

Establish and maintain measurement objectives derived from identified information needs and objectives.

Measurement objectives document the purposes for which measurement and analysis are done and specify the kinds of actions that may be taken based on results of data analyses.

Measurement objectives focus on acquirer performance, supplier performance, and understanding the effects of their performance on customer operational and financial performance. Measurement objectives for the supplier enable defining and tracking service level expectations documented in the supplier agreement.

Measurement objectives identify what information is needed to do the following:

- Maintain alignment to project objectives and provide results that keep a project on track to its successful conclusion
- Support the organization's ability to establish an infrastructure that reinforces and grows acquirer capabilities, including processes, people, and technologies, as appropriate
- Support the enterprise's ability to monitor and manage its financial results and customer expectations, as appropriate

Sources of measurement objectives include management, technical, project, product, and process implementation needs.

Measurement objectives may be constrained by existing processes, available resources, or other measurement considerations. Judgments may need to be made about whether the value of the result is commensurate with resources devoted to doing the work.

Modifications to identified information needs and objectives may, in turn, be indicated as a consequence of the process and results of measurement and analysis.

Sources of information needs and objectives may include the following:

- Project plans
- Project performance monitoring
- Interviews with managers and others who have information needs
- Established management objectives
- Strategic plans
- Business plans
- Formal requirements or contractual obligations
- Recurring or other troublesome management or technical problems
- Experiences of other projects or organizational entities
- External industry benchmarks
- Process improvement plans
- Supplier agreements and contractual requirements (e.g., service levels)
- Customer expectations

Example measurement objectives include the following:

- Reduce time to delivery
- Reduce total lifecycle costs
- Deliver the specified functionality completely
- Improve prior levels of quality
- Improve prior customer satisfaction ratings
- Maintain and improve the relationships between the acquirer and supplier

Refer to the Project Planning process area for more information about estimating project attributes and other planning information needs.

Refer to the Project Monitoring and Control process area for more information about project performance information needs.

Refer to the Requirements Management process area for more information about maintaining requirements traceability and related information needs.

Typical Work Products

1. Measurement objectives

Subpractices

1. Document information needs and objectives.
2. Prioritize information needs and objectives.
3. Document, review, and update measurement objectives.

Carefully consider the purposes and intended uses of measurement and analysis.

Measurement objectives are documented, reviewed by management and other relevant stakeholders, and updated as necessary. Completing these activities enables traceability to subsequent measurement and analysis activities and helps ensure that analyses will properly address identified information needs and objectives.

4. Provide feedback for refining and clarifying information needs and objectives as necessary.

Identified information needs and objectives may be refined and clarified as a result of setting measurement objectives. Initial descriptions of information needs may be unclear or ambiguous. Conflicts may arise between existing needs and objectives. Precise targets on an already existing measure may be unrealistic.

5. Review appropriate measurement objectives with potential suppliers throughout the solicitation, obtaining their feedback and commitment.

*Refer to the **Solicitation and Supplier Agreement Development** process area for more information about solicitations and interacting with potential suppliers.*

6. Maintain traceability of measurement objectives to identified information needs and objectives.

Of course, measurement objectives may also change to reflect evolving information needs and objectives.

SP 1.2 Specify Measures

Specify measures to address measurement objectives.

Measurement objectives are refined into precise, quantifiable measures.

Measurement of project and organizational work can typically be traced to one or more measurement information categories. These categories include the following: schedule and progress, effort and cost, size and stability, and quality.

Measures may be either *base* or *derived*. Data for base measures are obtained by direct measurement. Data for derived measures come from other data, typically by combining two or more base measures.

Derived measures typically are expressed as ratios, composite indices, or other aggregate summary measures. They are often more quantitatively reliable and meaningfully interpretable than the base measures used to generate them.

Base measures enable the creation of many derived measures or indicators from the same standard data sources. In addition, there is a direct relationship between measurement objectives, measurement categories, base measures, and derived measures. This direct relationship is depicted using some common examples in Table 16.1:

Table 16.1: Example Measurement Relationships

<i>Example Measurement Objectives</i>	<i>Measurement Information Categories</i>	<i>Example Base Measures</i>	<i>Example Derived Measures</i>
Shorter Time to Delivery	Schedule and Progress	Estimated and Actual Start and End Dates by Task Estimated and Actual Start and End Dates of Acquisition Tasks	Milestone Performance Percentage of Project on Time Schedule Estimation Accuracy
Reduced Total Lifecycle Cost	Effort and Cost	Estimated and Actual Effort Hours	Return on Investment
		Estimated and Actual Cost	Cost Variance
Deliver Specified Functionality Completely	Size and Stability	Requirements Count	Requirements Volatility Size Estimation Accuracy
		Function Point Count	Estimated and Actual Function Points Completed
		Lines of Code Count	Amount of New, Modified, and Reused Code
Improve Levels of Quality	Quality	Product Defects Count	Defect Removal Efficiency Number of Defects Per Phase Total Unresolved Defects
		Customer Satisfaction Survey Scores	Customer Satisfaction Trends
		Supplier Performance and Relationship Scores	Supplier Performance and Relationship Trends
		Web Site Response Time	Variance from Throughput Target

As a part of their measurement and analysis activities, projects may also consider the use of Earned Value Management (EVM) for measures related to cost and schedule [GEIA 748 2002]. EVM is a method for objectively measuring cost and schedule progress and for predicting estimated total costs and target completion dates based on past and current performance trends.

Typical EVM data include the planned cost of accomplishing specific and measurable tasks, the actual cost of completing tasks, and earned value, which is the planned cost of the work actually completed for each task. Using these or similar base measures, the project can calculate derived measures such as schedule and cost variance and more complex measures. These include schedule and cost performance indices. EVM derived measures can assist with estimating the cost for completion and additional resources that may be required.

To manage projects, an acquirer uses supplier data (i.e., base measures) and supplier-reported derived measures in addition to measures of acquirer progress and output. Supplier measures required by the acquirer allow the acquirer to comprehensively address measurement objectives and to comprehensively determine the progress of the project. In some cases, these supplier measures will augment acquirer measures (e.g., supplier's schedule performance index and size estimation accuracy).

In most cases, supplier measures are the primary source of data, especially with regard to the development of the acquired product or service. For instance, measurement and analysis of the product or product components provided by a supplier through technical performance measures is essential for effective management. Technical performance measures are precisely defined measures based on a product requirement, product capability, or some combination of requirements and capabilities.

It is important to use measures to track high-risk items to closure and to help determine risk mitigation and corrective actions. These supplier measures must be defined in the supplier agreement, including a supplier's measurement collection requirements and measurement reports to be provided to the acquirer.

Typical Work Products

1. Specifications of base and derived measures
2. Acceptance criteria for supplier measures

Subpractices

1. Identify candidate measures based on documented measurement objectives.

Measurement objectives are refined into measures. Identified candidate measures are categorized and specified by name and unit of measure.

2. Identify existing measures that already address measurement objectives.

Specifications for measures may already exist, perhaps established for other purposes earlier or elsewhere in the organization.

3. Specify operational definitions for measures.

Operational definitions are stated in precise and unambiguous terms. They address two important criteria:

- Communication: What has been measured, how was it measured, what are the units of measure, and what has been included or excluded?
- Repeatability: Can the measurement be repeated, given the same definition, to get the same results?

4. Specify acceptance criteria based on operational definitions for measures that come from suppliers to the acquirer in a way that enables their intended use.

Measures may be provided by the supplier as detailed measurement data or measurement reports. Measures that come from suppliers must be associated with the acquirer's acceptance criteria for supplier measures. Acceptance criteria may be captured in measurement specifications or by checklists.

Acceptance criteria should be defined in a way that enables the intended use of supplier measures, such as potential aggregation and analysis. These criteria must include criteria associated with the collection and transfer mechanisms and procedures that must be performed by the supplier. Consider all characteristics about supplier measures that may impact their use, such as differences in financial calendars used by different suppliers.

5. Prioritize, review, and update measures.

Proposed specifications of measures are reviewed for their appropriateness with potential end users and other relevant stakeholders. Priorities are set or changed, and specifications of measures are updated as necessary.

SP 1.3 Specify Data Collection and Storage Procedures

Specify how measurement data is obtained and stored.

Explicit specification of collection methods helps ensure that the right data are collected properly. This specification may also help further clarify information needs and measurement objectives.

Proper attention to storage and retrieval procedures helps ensure that data are available and accessible for future use.

The supplier agreement specifies the measurement data the supplier must provide to the acquirer, in what format they have to be provided to the acquirer, how the measurement data will be collected and stored by the supplier (e.g., retention period of data), how and how often they will be transferred to the acquirer, and who has access to data. Some supplier data may be considered proprietary by the supplier and may need to be protected as such by the acquirer. Also consider that some acquirer measurement data (e.g., total project cost data) may be proprietary and should not be shared with suppliers. An acquirer must plan for the collection, storage, and access control of sensitive data.

The acquirer must ensure that appropriate mechanisms are in place to obtain measurement data from the supplier in a consistent way. It is critical for the acquirer to insist in the supplier agreement on accurate data collection by the supplier for the acquirer's measurement and analysis.

Typical Work Products

1. Data collection and storage procedures
2. Data collection tools

Typical Supplier Deliverables

1. Recommendations for data collection and storage procedures

Subpractices

1. Identify existing sources of data that are generated from current work products, processes, or transactions.
2. Identify measures for which data are needed but are not currently available.
3. Specify how to collect and store the data for each required measure.

Explicit specifications are made of how, where, and when data will be collected. Procedures for collecting valid data are specified. Data are stored in an accessible manner for analysis. This analysis helps determine whether data will be saved for possible reanalysis or documentation purposes.

Questions to be considered typically include the following:

- Have the frequency of collection and points in the process where measurements will be made been determined?
- Has the timeline that is required to move measurement results from points of collection to repositories, other databases, or end users been established?
- Who is responsible for obtaining data?
- Who is responsible for data storage, retrieval, and security?
- Have necessary supporting tools been developed or acquired?
- Have required data collection requirements and applicable procedures been specified in supplier agreement standards and related documents?

4. Create data collection mechanisms and process guidance.

Data collection and storage mechanisms are well integrated with other normal work processes. Data collection mechanisms may include manual or automated forms and templates. Clear, concise guidance on correct procedures is available to those responsible for doing the work. Training is provided as needed to clarify processes required for the collection of complete and accurate data and to minimize the burden on those who must provide and record data.

Create mechanisms to transfer data and process guidance from the supplier to the acquirer, as appropriate. Data collection from a supplier may be integrated with periodic monitoring and review of supplier activities. Applicable standard report formats and tools to be used for reporting by the supplier must be specified in the supplier agreement.

5. Support automatic collection of data as appropriate and feasible.
6. Prioritize, review, and update data collection and storage procedures.

Proposed procedures are reviewed for their appropriateness and feasibility with those who are responsible for providing, collecting, and storing data. They also may have useful insights about how to improve existing processes or may be able to suggest other useful measures or analyses.

Review data collection and storage procedures with potential suppliers throughout the solicitation. Update data collection and storage procedures, as appropriate, and obtain supplier commitment to collect and store measurement data and reference procedures in the supplier agreement.

7. Update measures and measurement objectives as necessary.

SP 1.4 Specify Analysis Procedures

Specify how measurement data are analyzed and communicated.

Specifying analysis procedures in advance ensures that appropriate analyses will be conducted and reported to address documented measurement objectives (and thereby the information needs and objectives on which they are based). This approach also provides a check that necessary data will, in fact, be collected.

The supplier agreement defines the required data analysis and the definition and examples of measures the supplier must provide to the acquirer.

Typical Work Products

1. Analysis specifications and procedures
2. Data analysis tools

Typical Supplier Deliverables

1. Recommendations for analysis specification and procedures

Subpractices

1. Specify and prioritize the analyses to be conducted and the reports to be prepared.

Early on, pay attention to the analyses to be conducted and to the manner in which results will be reported. These should meet the following criteria:

- The analyses explicitly address the documented measurement objectives.
- Presentation of results is clearly understandable by the audiences to whom the results are addressed.

Priorities may have to be set within available resources.

Establish and maintain a description of the analysis approach for data elements, a description of reports that must be provided by the supplier; and a reference to analysis specifications and procedures in the supplier agreement.

2. Select appropriate data analysis methods and tools.

Refer to the Select Measures and Analytic Techniques specific practice and Apply Statistical Methods to Understand Variation specific practice of the Quantitative Project Management process area for more information about the appropriate use of statistical analysis techniques and understanding variation.

Descriptive statistics are typically used in data analysis to do the following:

- Examine distributions on specified measures (e.g., central tendency, extent of variation, or data points exhibiting unusual variation)
- Examine interrelationships among specified measures (e.g., comparisons of defects by phase of the product's lifecycle or by product component)
- Display changes over time

3. Specify administrative procedures for analyzing data and communicating results.

Data collected from a supplier are subject to validity checks that can be achieved by periodic audits of the supplier's execution of data collection and analysis procedures for acquirer-required measures. The acquirer's option to perform validity checks of measurement data collected by the supplier and the supplier's execution of required analysis procedures must be defined in the supplier agreement.

4. Review and update the proposed content and format of specified analyses and reports.

All of the proposed content and format are subject to review and revision, including analytic methods and tools, administrative procedures, and priorities. Relevant stakeholders consulted should include end users, sponsors, data analysts, and data providers.

Review specified analyses and reports with suppliers and identify their commitment to support the analysis, and review recommendations they may provide related to the analysis of measurement data.

5. Update measures and measurement objectives as necessary.

Just as measurement needs drive data analysis, clarification of analysis criteria can affect measurement. Specifications for some measures may be refined further based on specifications established for data analysis procedures. Other measures may prove unnecessary, or a need for additional measures may be recognized.

Specifying how measures will be analyzed and reported may also suggest the need for refining measurement objectives themselves.

6. Specify criteria for evaluating the utility of analysis results and for evaluating the conduct of measurement and analysis activities.

Criteria for evaluating the utility of the analysis might address the extent to which the following apply:

- The results are (1) provided in a timely manner, (2) understandable, and (3) used for decision making.
- The work does not cost more to perform than is justified by the benefits it provides.

Criteria for evaluating the conduct of the measurement and analysis might include the extent to which the following apply:

- The amount of missing data or the number of flagged inconsistencies is beyond specified thresholds.
- There is selection bias in sampling (e.g., only satisfied end users are surveyed to evaluate end-user satisfaction, or only unsuccessful projects are evaluated to determine overall productivity).
- Measurement data are repeatable (e.g., statistically reliable).
- Statistical assumptions have been satisfied (e.g., about the distribution of data or about appropriate measurement scales).

SG 2 Provide Measurement Results

Measurement results, which address identified information needs and objectives, are provided.

The primary reason for conducting measurement and analysis is to address identified information needs and objectives. Measurement results based on objective evidence can help to monitor performance, fulfill obligations documented in a supplier agreement, make informed management and technical decisions, and enable corrective actions to be taken.

SP 2.1 Obtain Measurement Data

Obtain specified measurement data.

Data necessary for analysis are obtained and checked for completeness and integrity.

Supplier measurement data are collected according to data collection and storage procedures as defined in the supplier agreement. Data necessary for analysis are obtained and checked for completeness and integrity.

Typical Work Products

1. Base and derived measurement data sets
2. Results of data integrity tests

Typical Supplier Deliverables

1. Base and derived supplier measurement data sets
2. Results of data integrity tests of supplier measurement data

Subpractices

1. Obtain data for base measures.

Data are collected as necessary for previously used and newly specified base measures. Existing data are gathered from project records or elsewhere in the organization.

Data are obtained from the supplier for base measures as defined in the supplier agreement.

2. Generate data for derived measures.

Values are newly calculated for all derived measures.

Derived measures are obtained from the supplier as defined in the supplier agreement.

3. Perform data integrity checks as close to the source of data as possible.

All measurements are subject to error in specifying or recording data. It is always better to identify these errors and sources of missing data early in the measurement and analysis cycle.

Checks can include scans for missing data, out-of-bounds data values, and unusual patterns and correlation across measures. It is particularly important to do the following:

- Test and correct for inconsistency of classifications made by human judgment (i.e., to determine how frequently people make differing classification decisions based on the same information, otherwise known as *inter-coder reliability*).
- Empirically examine the relationships among measures that are used to calculate additional derived measures. Doing so can ensure that important distinctions are not overlooked and that derived measures convey their intended meanings (otherwise known as *criterion validity*).

Use acceptance criteria to verify the results of data integrity tests conducted by the supplier and to verify the integrity of supplier data. Follow up with suppliers if data are not available or data integrity checks indicate potential errors in data.

Refer to the Agreement Management process area for more information about resolving supplier agreement issues.

SP 2.2 Analyze Measurement Data

Analyze and interpret measurement data.

Measurement data are analyzed as planned, additional analyses are conducted as necessary, results are reviewed with relevant stakeholders, and necessary revisions for future analyses are noted.

Typical Work Products

1. Analysis results and draft reports

Typical Supplier Deliverables

1. Responses to analysis results and draft reports

Subpractices

1. Conduct initial analyses, interpret results, and draw preliminary conclusions.

The results of data analyses are rarely self-evident. Criteria for interpreting results and drawing conclusions should be stated explicitly.

Discuss results and preliminary conclusions with suppliers, as appropriate.

2. Conduct additional measurement and analysis as necessary, and prepare results for presentation.

Results of planned analyses may suggest (or require) additional, unanticipated analyses. In addition, these analyses may identify needs to refine existing measures, to calculate additional derived measures, or even to collect data for additional base measures to properly complete the planned analysis. Similarly, preparing initial results for presentation may identify the need for additional, unanticipated analyses.

Coordinate additional analyses with suppliers, as appropriate.

3. Review initial results with relevant stakeholders.

It may be appropriate to review initial interpretations of results and the way in which these results are presented before disseminating and communicating them widely.

Relevant stakeholders with whom reviews may be conducted include intended end users and sponsors, as well as data analysts and data providers.

Review initial results related to supplier progress or output with suppliers and determine if revisions are appropriate based on their response.

4. Refine criteria for future analyses.

Lessons that can improve future efforts are often learned from conducting data analyses and preparing results. Similarly, ways to improve measurement specifications and data collection procedures may become apparent, as may ideas for refining identified information needs and objectives.

Update data acceptance criteria for supplier measures, as appropriate.

SP 2.3 Store Data and Results

Manage and store measurement data, measurement specifications, and analysis results.

Storing measurement-related information enables its timely and cost-effective use as historical data and results. The information also is needed to provide sufficient context for interpretation of data, measurement criteria, and analysis results.

Information stored typically includes the following:

- Measurement plans
- Specifications of measures
- Sets of data that were collected
- Analysis reports and presentations
- Retention period for data stored
- Data acceptance criteria for supplier data

Stored information contains or references other information needed to understand and interpret the measures and to assess them for reasonableness and applicability (e.g., measurement specifications used on different projects when comparing across projects).

Typically, data sets for derived measures can be recalculated and need not be stored. However, it may be appropriate to store summaries based on derived measures (e.g., charts, tables of results, or report prose).

Interim analysis results need not be stored separately if they can be efficiently reconstructed.

Projects may choose to store project-specific data and results in a project-specific repository. When data are shared across projects, they may reside in the organization's measurement repository.

Refer to the Establish the Organization's Measurement Repository specific practice of the Organizational Process Definition process area for more information about establishing the organization's measurement repository.

Refer to the Configuration Management process area for more information about managing measurement work products.

Typical Work Products

1. Stored data inventory

Subpractices

1. Review data to ensure their completeness, integrity, accuracy, and currency.
2. Store data according to data storage procedures.
3. Make stored contents available for use only to appropriate groups and personnel.

The acquirer protects measurement data provided by the supplier according to the supplier agreement. The supplier agreement might specify that the acquirer must restrict access to a supplier's measurement data to acquirer employees only.

4. Prevent stored information from being used inappropriately.

Examples of inappropriate use include the following:

- Disclosure of information provided in confidence
- Faulty interpretations based on incomplete, out-of-context, or otherwise misleading information
- Measures used to improperly evaluate the performance of people or to rank projects
- Impugning the integrity of individuals

SP 2.4

Communicate Results

Communicate results of measurement and analysis activities to all relevant stakeholders.

The results of the measurement and analysis process are communicated to relevant stakeholders in a timely and usable fashion to support decision making and assist in taking corrective action.

Relevant stakeholders include intended users, sponsors, data analysts, and data providers.

Relevant stakeholders also include suppliers.

Typical Work Products

1. Delivered reports and related analysis results
2. Contextual information or guidance to help interpret analysis results

Subpractices

1. Keep relevant stakeholders apprised of measurement results in a timely manner.

To the extent possible and as part of the normal way they do business, users of measurement results are kept personally involved in setting objectives and deciding on plans of action for measurement and analysis. Users are regularly kept apprised of progress and interim results.

Refer to the Project Monitoring and Control process area for more information about the use of measurement results.

2. Assist relevant stakeholders in understanding results.

Results are communicated in a clear and concise manner appropriate to the methodological sophistication of relevant stakeholders. Results are understandable, easily interpretable, and clearly tied to identified information needs and objectives.

The acquirer establishes and maintains a standard format for communicating measurement data to relevant stakeholders.

Data are often not self-evident to practitioners who are not measurement experts. The following measurement choices should be explicitly clarified:

- How and why base and derived measures were specified
- How data were obtained
- How to interpret results based on the data analysis methods used
- How results address information needs

Examples of actions to assist in understanding results include the following:

- Discussing the results with relevant stakeholders
- Providing a transmittal memo that provides background and explanation
- Briefing users on results
- Providing training on the appropriate use and understanding of measurement results

ORGANIZATIONAL INNOVATION AND DEPLOYMENT

A Process Management Process Area at Maturity Level 5

Purpose

The purpose of Organizational Innovation and Deployment (OID) is to select and deploy incremental and innovative improvements that measurably improve the organization's processes and technologies. These improvements support the organization's quality and process-performance objectives as derived from the organization's business objectives.

Introductory Notes

The Organizational Innovation and Deployment process area enables the selection and deployment of improvements that can enhance the organization's ability to meet its quality and process-performance objectives. (See the definition of "quality and process-performance objectives" in the glossary.)

The term *improvement*, as used in this process area, refers to all ideas (proven and unproven) that would change the organization's processes and technologies to better meet the organization's quality and process-performance objectives.

Quality and process-performance objectives that this process area might address include the following:

- Improved product quality (e.g., functionality, performance)
- Increased productivity
- Decreased cycle time
- Greater customer and end-user satisfaction
- Shorter development or production time to change functionality, add new features, or adapt to new technologies
- Reduce delivery time
- Reduce time to adapt to new technologies and business needs
- Improved performance of a supply-chain involving multiple suppliers
- Improved inter-supplier performance
- Improved utilization of resources across the organization

Achievement of these objectives depends on the successful establishment of an infrastructure that enables and encourages all people in the organization to propose potential improvements to the organization's processes and technologies. Achievement of these objectives also depends on being able to effectively evaluate and deploy proposed improvements to the organization's processes and technologies. All members of the organization can participate in the organization's process- and technology-improvement activities. Their proposals are systematically gathered and addressed.

Improvements may be identified and executed by the acquirer or the supplier. The acquirer encourages all suppliers to participate in the acquirer's process- and technology-improvement activities. Some selected improvements may be deployed across acquirer and supplier organizations.

The acquirer and suppliers may share the costs and benefits of improvements. Acquirers may increase the incentive for suppliers to participate in improvement efforts across the supply chain by allowing suppliers to appropriate the entire value derived from a contributed improvement for an initial period (e.g., 6 to 18 months). Over time, the supplier may be expected to share a proportion of those savings with the acquirer (e.g., through cost reductions to the acquirer). Acquirer and supplier expectations related to participation in process- and technology-improvement activities, and the sharing of associated costs and benefits, should be documented in the supplier agreement.

Pilots are conducted to evaluate significant changes involving untried, high-risk, or innovative improvements before they are broadly deployed.

Process and technology improvements to be deployed across the organization are selected from process- and technology-improvement proposals based on the following criteria:

- A quantitative understanding of the organization's current quality and process performance
- The organization's quality and process-performance objectives
- Estimates of the improvement in quality and process performance resulting from deploying the process and technology improvements
- Estimated costs of deploying process and technology improvements, and resources and funding available for such deployment

Expected benefits added by the process and technology improvements are weighed against the cost and impact to the organization. Change and stability must be balanced carefully. Change that is too great or too rapid can overwhelm the organization, destroying its investment in organizational learning represented by organizational process assets. Rigid stability can result in stagnation, allowing the changing business environment to erode the organization's business position.

Improvements are deployed, as appropriate, to new and ongoing projects.

In this process area, the term *process and technology improvements* refers to incremental and innovative improvements to processes and also to process or product technologies (including project work environments).

The informative material in this process area is written assuming the specific practices are applied in an organization that has a quantitative understanding of its standard processes and their expected quality and performance in predictable situations. Specific practices of this process area may be applicable, but with reduced value, if this assumption is not met.

The specific practices in this process area complement and extend those found in the Organizational Process Focus process area. The focus of this process area is process improvement based on a quantitative understanding of the organization's set of standard processes and technologies and their expected quality and performance in predictable situations. In the Organizational Process Focus process area, no assumptions are made about the quantitative basis of improvement.

Related Process Areas

Refer to the Organizational Process Focus process area for more information about soliciting, collecting, and handling process improvement proposals and coordinating the deployment of process improvements into projects' defined processes.

Refer to the Organizational Training process area for more information about providing updated training to support the deployment of process and technology improvements.

Refer to the Organizational Process Performance process area for more information about quality and process-performance objectives and process-performance models. Quality and process-performance objectives are used to analyze and select process- and technology-improvement proposals for deployment. Process-performance models are used to quantify the impact and benefits of innovations.

Refer to the Measurement and Analysis process area for more information about establishing objectives for measurement and analysis, specifying measures and analyses to be performed, obtaining and analyzing measures, and reporting results.

Refer to the Integrated Project Management process area for more information about implementing process and technology improvements into the project's defined process and project work environment.

Refer to the Decision Analysis and Resolution process area for more information about formal evaluations when selecting improvement proposals and innovations.

Specific Goal and Practice Summary

SG 1 Select Improvements

SP 1.1 Collect and Analyze Improvement Proposals

SP 1.2 Identify and Analyze Innovations

SP 1.3 Pilot Improvements

SP 1.4 Select Improvements for Deployment

SG 2 Deploy Improvements

SP 2.1 Plan the Deployment

SP 2.2 Manage the Deployment

SP 2.3 Measure Improvement Effects

Specific Practices by Goal

SG 1 Select Improvements

Process and technology improvements, which contribute to meeting quality and process-performance objectives, are selected.

SP 1.1 Collect and Analyze Improvement Proposals

Collect and analyze process- and technology-improvement proposals.

Each process- and technology-improvement proposal must be analyzed.

The acquirer must continuously improve its processes and its alignment with its customer and suppliers. The acquirer may look for opportunities to maximize throughput based on the identification of the most limiting resource and, as a result, create a more agile supply chain (e.g., giving higher priority to improvement proposals that promote a supply chain that responds both quickly and cost effectively).

Simple process and technology improvements, with well-understood benefits and effects, will not usually undergo detailed evaluations.

An example of a simple process and technology improvement is to establish guidelines for multiple-supplier interactions.

Typical Work Products

1. Analyzed process- and technology-improvement proposals

Typical Supplier Deliverables

1. Process- and technology-improvement proposals

Subpractices

1. Collect process- and technology-improvement proposals.

A process- and technology-improvement proposal documents proposed incremental and innovative improvements to processes and technologies. Managers and staff in the organization, as well as customers, end users, and suppliers can submit process- and technology-improvement proposals. Process and technology improvements may be implemented at the local level before being proposed for the organization.

Examples of sources for process- and technology-improvement proposals include the following:

- Findings and recommendations from process appraisals
- Templates for acquirer work products
- The organization's quality and process-performance objectives
- Analysis of data about customer and end-user problems as well as customer and end-user satisfaction
- Analysis of data about project performance compared to quality and productivity objectives
- Analysis of technical performance measures
- Results of process and product benchmarking efforts
- Analysis of data on defect causes
- Measured effectiveness of process activities
- Measured effectiveness of project work environments
- Examples of process- and technology-improvement proposals that were successfully adopted elsewhere
- Feedback on previously submitted process- and technology-improvement proposals
- Spontaneous ideas from managers and staff
- Findings and recommendations from joint acquirer and supplier study groups

Refer to the Organizational Process Focus process area for more information about process- and technology-improvement proposals.

2. Analyze the costs and benefits of process- and technology-improvement proposals, as appropriate.

Criteria for evaluating costs and benefits include the following:

- Contribution toward meeting the organization's quality and process-performance objectives
- Effect on mitigating identified project and organizational risks
- Ability to respond quickly to changes in project requirements, market situations, and the business environment
- Effect on related processes and associated assets
- Cost of defining and collecting data that supports the measurement and analysis of the process- and technology-improvement proposal
- Expected life span of the proposal

Process-performance models provide insight into the effect of process changes on process capability and performance.

Refer to the Organizational Process Performance process area for more information about process-performance models.

3. Identify the process- and technology-improvement proposals that are innovative.

Innovative improvements are also identified and analyzed in the Identify and Analyze Innovations specific practice.

Whereas this specific practice analyzes proposals that have been passively collected, the purpose of the Identify and Analyze Innovations specific practice is to actively search for and locate innovative improvements. The search primarily involves looking outside the organization.

Innovative improvements are typically identified by reviewing process- and technology-improvement proposals or by actively investigating and monitoring innovations that are in use in other organizations or are documented in research literature. Innovation may be inspired by internal improvement objectives or by the external business environment.

Innovative improvements are typically major changes to the process that represent a break from the old way of doing things (e.g., changing the lifecycle model). Innovative improvements may also include changes in products that support, enhance, or automate the process (e.g., using off-the-shelf products to support the process).

Examples of innovative improvements include addition of, or major updates to, the following:

- Support tools
- Processes or lifecycle models
- Interface standards
- Reusable components
- Management techniques and methodologies
- Quality-improvement techniques and methodologies

4. Identify potential barriers and risks to deploying each process- and technology-improvement proposal.

Examples of barriers to deploying process and technology improvements include the following:

- Turf guarding and parochial perspectives
- Unclear or weak business rationale
- Lack of short-term benefits and visible successes
- Unclear picture of what is expected from everyone
- Too many changes at the same time
- Lack of involvement and support from relevant stakeholders

Examples of risk factors that affect the deployment of process and technology improvements include the following:

- Compatibility of the improvement with existing processes, values, and skills of potential end users
- Complexity of the improvement
- Difficulty implementing the improvement
- Ability to demonstrate the value of the improvement before widespread deployment
- Justification for large, up-front investments in areas such as tools and training
- Inability to overcome "technology drag" where the current implementation is used successfully by a large and mature installed base of end users
- Additional cost to the customer or supplier
- Misalignment of customer, acquirer, and supplier improvement priorities

5. Estimate the cost, effort, and schedule required for deploying each process- and technology-improvement proposal.

6. Select the process- and technology-improvement proposals to be piloted before broadscale deployment.

Since innovations, by definition, usually represent a major change, most innovative improvements will be piloted.

7. Document results of the evaluation of each process- and technology-improvement proposal.
8. Monitor the status of each process- and technology-improvement proposal.

SP 1.2 Identify and Analyze Innovations

Identify and analyze innovative improvements that could increase the organization's quality and process performance.

The specific practice, Collect and Analyze Improvement Proposals, analyzes proposals that are passively collected. The purpose of this specific practice is to actively search for, locate, and analyze innovative improvements. This search primarily involves looking outside the organization.

An acquirer's customers and suppliers are vital sources of innovative ideas. Inter-organizational and organizational learning are therefore critical to actively identifying and analyzing innovations.

Typical Work Products

1. Candidate innovative improvements
2. Analysis of proposed innovative improvements

Typical Supplier Deliverables

1. Candidate innovative improvements

Subpractices

1. Analyze the organization's set of standard processes to determine areas in which innovative improvements would be most helpful.

These analyses are performed to determine which subprocesses are critical to achieving the organization's quality and process-performance objectives and which ones are good candidates to be improved.

2. Investigate innovative improvements that may improve the organization's set of standard processes.

Investigating innovative improvements involves the following activities:

- Systematically maintaining awareness of leading relevant technical work and technology trends
- Periodically searching for commercially available innovative improvements
- Collecting proposals for innovative improvements from projects and the organization
- Systematically reviewing processes and technologies used externally and comparing them to those used in the organization

- Identifying areas in which innovative improvements have been used successfully, and reviewing data and documentation of experience using these improvements
- Identifying improvements that integrate new technology into products and project work environments
- Determining where supplier products stand in relation to technology cycles and product lifecycles
- Monitoring economies all over the world to spot new supply bases and markets

3. Analyze potential innovative improvements to understand their effects on process elements and predict their influence on the process.

The acquirer and its suppliers may establish an innovation review program. This program may create time-boxed innovation solicitation, which is a well-communicated formal process for analysis and guaranteed response to innovative ideas proposed by customers, employees, and suppliers.

Process-performance models can provide a basis for analyzing possible effects of changes to process elements.

Refer to the Organizational Process Performance process area for more information about process-performance models.

4. Analyze the costs and benefits of potential innovative improvements.
5. Create process- and technology-improvement proposals for those innovative improvements that would result in improving the organization's processes or technologies.
6. Select innovative improvements to be piloted before broadscale deployment.

Since innovations, by definition, usually represent a major change, most innovative improvements will be piloted.

7. Document results of evaluations of innovative improvements.

SP 1.3 Pilot Improvements

Pilot process and technology improvements to select which ones to implement.

Pilots are performed to assess new and unproven major changes before they are broadly deployed, as appropriate.

The implementation of this specific practice may overlap with the implementation of the Implement Action Proposals specific practice in the Causal Analysis and Resolution process area (e.g., when causal analysis and resolution is implemented organizationally or across multiple projects).

Typical Work Products

1. Pilot evaluation reports
2. Documented lessons learned from pilots

Typical Supplier Deliverables

1. Pilot evaluation reports for pilots executed in the supplier environment
2. Documented lessons learned from pilots executed in the supplier environment

Subpractices

1. Plan the pilots.

When planning pilots, define quantitative criteria to be used for evaluating pilot results.

2. Review and get relevant stakeholder agreement on plans for pilots.
3. Consult with and assist those performing the pilots.
4. Perform each pilot in an environment that is characteristic of the environment present in a broadscale deployment.
5. Track pilots against their plans.
6. Review and document results of pilots.

Pilot results are evaluated using the quantitative criteria defined during pilot planning. Reviewing and documenting results of pilots usually involves the following activities:

- Deciding whether to terminate the pilot, replan and continue the pilot, or proceed with deploying the process and technology improvement
- Updating the disposition of process- and technology-improvement proposals associated with the pilot
- Identifying and documenting new process- and technology-improvement proposals, as appropriate
- Identifying and documenting lessons learned and problems encountered during the pilot

SP 1.4

Select Improvements for Deployment

Select process and technology improvements for deployment across the organization.

Selection of process and technology improvements for deployment across the organization is based on quantifiable criteria derived from the organization's quality and process-performance objectives.

Typical Work Products

1. Process and technology improvements selected for deployment

Subpractices

1. Prioritize candidate process and technology improvements for deployment.

Priority is based on an evaluation of the estimated cost-to-benefit ratio with regard to the quality and process-performance objectives.

Refer to the Organizational Process Performance process area for more information about quality and process-performance objectives.

2. Select the process and technology improvements to be deployed.

The selection of process improvements is based on their priorities and available resources.

3. Determine how each process and technology improvement will be deployed.

Examples of where the process and technology improvements may be deployed include the following:

- Organizational process assets
- Project-specific or common work environments
- Organization's product families
- Organization's capabilities
- Organization's projects
- Organizational groups

4. Document results of the selection process.

Results of the selection process usually include the following:

- The selection criteria for candidate improvements
- The disposition of each improvement proposal
- The rationale for the disposition of each improvement proposal
- The assets to be changed for each selected improvement

SG 2 Deploy Improvements

Measurable improvements to the organization's processes and technologies are continually and systematically deployed.

SP 2.1 Plan the Deployment

Establish and maintain plans for deploying selected process and technology improvements.

The plans for deploying selected process and technology improvements may be included in the organization's plan for organizational innovation and deployment or they may be documented separately.

An acquirer's plans for deploying improvements may include openly sharing most process knowledge and expertise with its suppliers. Any process related knowledge that the acquirer or one of its suppliers possesses is viewed as accessible to virtually any other supplier in the acquirer's supply chain (perhaps with the exception of a direct competitor).

The implementation of this specific practice complements the Deploy Organizational Process Assets specific practice in the Organizational Process Focus process area and adds the use of quantitative data to guide the deployment and to determine the value of improvements with respect to quality and process-performance objectives.

Refer to the Organizational Process Focus process area for more information about deploying organizational process assets.

This specific practice plans the deployment of selected process and technology improvements. The Plan the Process generic practice addresses comprehensive planning that covers the specific practices in this process area.

Typical Work Products

1. Deployment plans for selected process and technology improvements

Subpractices

1. Determine how each process and technology improvement must be adjusted for organization-wide deployment.

Process and technology improvements proposed in a limited context (e.g., for a single project) might need to be modified to work across the organization.

2. Determine the changes needed to deploy each process and technology improvement.

Examples of changes needed to deploy a process and technology improvement include the following:

- Process descriptions, standards, and procedures
- Work environments
- Education and training
- Skills
- Existing commitments
- Existing activities
- Continuing support to end users
- Organizational culture and characteristics
- Supplier agreements

3. Identify strategies that address potential barriers to deploying each process and technology improvement.
4. Establish measures and objectives for determining the value of each process and technology improvement with respect to the organization's quality and process-performance objectives.

Examples of measures for determining the value of a process and technology improvement include the following:

- Return on investment
- Time to recover the cost of the process or technology improvement
- Measured improvement in the project's or organization's product quality and process performance
- Number and types of project and organizational risks mitigated by the process or technology improvement
- Average time required to respond to changes in project requirements, market situations, and the business environment

Refer to the Measurement and Analysis process area for more information about establishing objectives for measurement and analysis, specifying measures and analyses to be performed, obtaining and analyzing measures, and reporting results.

5. Document the plans for deploying selected process and technology improvements.
6. Review and get agreement with relevant stakeholders on the plans for deploying selected process and technology improvements.
7. Revise the plans for deploying selected process and technology improvements as necessary.

SP 2.2 Manage the Deployment

Manage the deployment of selected process and technology improvements.

The implementation of this specific practice may overlap with the implementation of the Implement Action Proposals specific practice in the Causal Analysis and Resolution process area (e.g., when causal analysis and resolution is implemented organizationally or across multiple projects). The primary difference is that in the Causal Analysis and Resolution process area, planning is done to manage the removal of root causes of defects or problems from the project's defined process. In the Organizational Innovation and Deployment process area, planning is done to manage the deployment of improvements to the organization's processes and technologies that can be quantified against the organization's business objectives.

Typical Work Products

1. Updated training materials (to reflect deployed process and technology improvements)
2. Documented results of process- and technology-improvement deployment activities
3. Revised process- and technology-improvement measures, objectives, priorities, and deployment plans

Subpractices

1. Monitor the deployment of process and technology improvements using the deployment plans.
2. Coordinate the deployment of process and technology improvements across the organization.

Coordinating deployment includes the following activities:

- Coordinating activities of projects, support groups, and organizational groups for each process and technology improvement
- Coordinating activities for deploying related process and technology improvements

3. Quickly deploy process and technology improvements in a controlled and disciplined manner, as appropriate.

Examples of methods for quickly deploying process and technology improvements include the following:

- Using red-lines, process change notices, or other controlled process documentation as interim process descriptions
- Deploying process and technology improvements incrementally, rather than as a single deployment
- Providing comprehensive consulting to early adopters of the process and technology improvement in lieu of revised formal training

4. Incorporate process and technology improvements into organizational process assets, as appropriate.

Refer to the Organizational Process Definition process area for more information about organizational process assets.

5. Coordinate the deployment of process and technology improvements into the projects' defined processes, as appropriate.

Refer to the Organizational Process Focus process area for more information about coordinating the deployment of process improvements into projects' defined processes.

6. Provide consulting, as appropriate, to support deployment of process and technology improvements.

7. Provide updated training materials to reflect improvements to organizational process assets.

Refer to the Organizational Training process area for more information about training materials.

8. Confirm that the deployment of all process and technology improvements is completed.

9. Determine whether the ability of the defined process to meet quality and process-performance objectives is adversely affected by the process and technology improvement, and take corrective action as necessary.

Refer to the Quantitative Project Management process area for more information about quantitatively managing the project's defined process to achieve the project's established quality and process-performance objectives.

10. Document and review results of process- and technology-improvement deployment.

Documenting and reviewing results includes the following:

- Identifying and documenting lessons learned
- Identifying and documenting new process- and technology-improvement proposals
- Revising process- and technology-improvement measures, objectives, priorities, and deployment plans

SP 2.3 Measure Improvement Effects

Measure effects of deployed process and technology improvements.

Refer to the Measurement and Analysis process area for more information about establishing objectives for measurement and analysis, specifying measures and analyses to be performed, obtaining and analyzing measures, and reporting results.

The implementation of this specific practice may overlap with the implementation of the Evaluate the Effect of Changes specific practice in the Causal Analysis and Resolution process area (e.g., when causal analysis and resolution is implemented organizationally or across multiple projects).

Typical Work Products

1. Documented measures of the effects resulting from deployed process and technology improvements

Subpractices

1. Measure the actual cost, effort, and schedule for deploying each process and technology improvement.
2. Measure the value of each process and technology improvement.
3. Measure progress toward achieving the organization's quality and process-performance objectives.
4. Analyze progress toward achieving the organization's quality and process-performance objectives and take corrective action as needed.

Refer to the Organizational Process Performance process area for more information about process-performance analyses.

5. Store measures in the organization's measurement repository.

ORGANIZATIONAL PROCESS DEFINITION

A Process Management Process Area at Maturity Level 3

Purpose

The purpose of Organizational Process Definition (OPD) is to establish and maintain a usable set of organizational process assets and work environment standards.

Introductory Notes

Organizational process assets enable consistent process performance across the organization and provide a basis for cumulative, long-term benefits to the organization. (See the definition of “organizational process assets” in the glossary.)

The organization’s process asset library is a collection of items maintained by the organization for use by the organization’s people and projects. This collection of items includes descriptions of processes and process elements, descriptions of lifecycle models, process tailoring guidelines, process-related documentation, and data. The organization’s process asset library supports organizational learning and process improvement by allowing the sharing of best practices and lessons learned across the organization.

The acquirer’s organizational process assets also include acquisition guidance and practices established for use across acquisition projects and which refer to applicable statutes and regulations.

The organization’s set of standard processes also describes standard interactions with suppliers. Supplier interactions are characterized by the following typical items: deliverables expected from suppliers, acceptance criteria applicable to those deliverables, standards (e.g., architecture and technology standards), and standard milestone and progress reviews.

The organization’s set of standard processes is tailored by projects to create their defined processes. Other organizational process assets are used to support tailoring and implementing defined processes. Work environment standards are used to guide the creation of project work environments.

A standard process is composed of other processes (i.e., subprocesses) or process elements. A *process element* is the fundamental (i.e., atomic) unit of process definition that describes activities and tasks to consistently perform work. The process architecture provides rules for connecting the process elements of a standard process. The organization's set of standard processes may include multiple process architectures.

(See the definitions of "standard process," "process architecture," "subprocess," and "process element" in the glossary.)

Organizational process assets may be organized in many ways, depending on the implementation of the Organizational Process Definition process area. Examples include the following:

- Descriptions of lifecycle models may be part of the organization's set of standard processes, or they may be documented separately.
- The organization's set of standard processes may be stored in the organization's process asset library, or it may be stored separately.
- A single repository may contain both measurements and process-related documentation, or they may be stored separately.

Related Process Areas

Refer to the Organizational Process Focus process area for more information about organizational process-related matters.

Specific Goal and Practice Summary

SG 1 Establish Organizational Process Assets

- SP 1.1 Establish Standard Processes
- SP 1.2 Establish Lifecycle Model Descriptions
- SP 1.3 Establish Tailoring Criteria and Guidelines
- SP 1.4 Establish the Organization's Measurement Repository
- SP 1.5 Establish the Organization's Process Asset Library
- SP 1.6 Establish Work Environment Standards
- SP 1.7 Establish Rules and Guidelines for Integrated Teams

Specific Practices by Goal

SG 1 Establish Organizational Process Assets

A set of organizational process assets is established and maintained.

SP 1.1 Establish Standard Processes

Establish and maintain the organization's set of standard processes.

Standard processes may be defined at multiple levels in an enterprise and they may be related hierarchically. For example, an enterprise may have a set of standard processes that is tailored by individual organizations (e.g., a division or site) in the enterprise to establish their set of standard processes. The set of standard processes may also be tailored for each of the organization's business areas or product lines. Thus the *organization's set of standard processes* can refer to the standard processes established at the organization level and standard processes that may be established at lower levels, although some organizations may have only one level of standard processes. (See the definitions of "standard process" and "organization's set of standard processes" in the glossary.)

Multiple standard processes may be needed to address the needs of different application domains, lifecycle models, methodologies, and tools. The organization's set of standard processes contains process elements (e.g., a work product size-estimating element) that may be interconnected according to one or more process architectures that describe relationships among process elements.

The organization's set of standard processes typically includes technical, management, administrative, support, and organizational processes.

Basing standard processes on industry standards and widely accepted models, with common terminology and lexicon, enables seamless interactions between the acquirer and supplier. In a multi-supplier environment, this seamless interaction is most important for acquirer standard processes that directly interface with supplier processes. Also, there may be cost and coordination benefits from having suppliers work together to develop or reconcile common support processes that are aligned with acquirer processes.

The level of detail required for standard processes depends on the flexibility needed by an enterprise, for instance, based on differences in business context, project types, and application domains.

The organization's set of standard processes should collectively cover all processes needed by the organization and projects, including those addressed by the process areas at maturity level 2.

Typical Work Products

1. Organization's set of standard processes

Subpractices

1. Decompose each standard process into constituent process elements to the detail needed to understand and describe the process.

Each process element covers a bounded and closely related set of activities. The descriptions of process elements may be templates to be filled in, fragments to be completed, abstractions to be refined, or complete descriptions to be tailored or used unmodified. These elements are described in such detail that the process, when fully defined, can be consistently performed by appropriately trained and skilled people.

Examples of process elements include the following:

- Template for the conduct of management reviews
- Templates for supplier deliverables
- Common lexicon for directly interfacing acquirer and supplier processes
- Templates for standard supplier agreements
- Description of methods for verifying supplier estimates
- Description of standard acquisition approaches related to teaming with suppliers
- Description of standard acceptance criteria
- Description of standard decision making and issue resolution

2. Specify the critical attributes of each process element.

Examples of critical attributes include the following:

- Process roles
- Applicable standards
- Applicable procedures, methods, tools, and resources
- Process-performance objectives
- Entry criteria
- Inputs
- Product and process measures to be collected and used
- Verification points
- Outputs
- Interfaces
- Exit criteria

3. Specify relationships among process elements.

Examples of relationships include the following:

- Order of the process elements
- Interfaces among process elements
- Interfaces with external processes
- Interdependencies among process elements

The rules for describing relationships among process elements are referred to as the *process architecture*. The process architecture covers essential requirements and guidelines. Detailed specifications of these relationships are covered in descriptions of defined processes that are tailored from the organization's set of standard processes.

4. Ensure that the organization's set of standard processes adheres to applicable policies, standards and models.

Adherence to applicable process standards and models is typically demonstrated by developing a mapping from the organization's set of standard processes to relevant process standards and models. This mapping is a useful input to future appraisals.

5. Ensure that the organization's set of standard processes satisfies process needs and objectives of the organization.

Refer to the Organizational Process Focus process area for more information about establishing and maintaining the organization's process needs and objectives.

6. Ensure that there is appropriate integration among processes that are included in the organization's set of standard processes.

7. Document the organization's set of standard processes.

8. Conduct peer reviews on the organization's set of standard processes.

The acquirer's review of its standard processes can include the participation of suppliers for those processes and process elements that define standard interactions with suppliers.

9. Revise the organization's set of standard processes as necessary.

SP 1.2 Establish Lifecycle Model Descriptions

Establish and maintain descriptions of lifecycle models approved for use in the organization.

Lifecycle models may be developed for a variety of customers or in a variety of situations, since one lifecycle model may not be appropriate for all situations. Lifecycle models are often used to define phases of the project. Also, the organization may define different lifecycle models for each type of product and service it delivers.

Lifecycle models describe acquisition lifecycles, depending on the acquisition strategy chosen. The acquisition lifecycle typically begins with the pre-award phase of a supplier agreement, continues through the phases of awarding and managing the supplier agreement, and ends when the supplier agreement period of performance ends, usually with the acceptance and completion of the warranty for the acquired product and the transition of the product to the support organization.

Typical Work Products

1. Descriptions of lifecycle models

Subpractices

1. Select lifecycle models based on the needs of projects and the organization.
2. Document descriptions of lifecycle models.

Lifecycle models may be documented as part of the organization's standard process descriptions or they may be documented separately.

3. Conduct peer reviews on lifecycle models.

The acquirer's review of lifecycle models should include the participation of suppliers for those processes and process elements that define expectations and constraints for suppliers.

4. Revise the descriptions of lifecycle models as necessary.

SP 1.3 Establish Tailoring Criteria and Guidelines

Establish and maintain tailoring criteria and guidelines for the organization's set of standard processes.

Tailoring criteria and guidelines describe the following:

- How the organization's set of standard processes and organizational process assets are used to create defined processes
- Mandatory requirements that must be satisfied by defined processes (e.g., the subset of organizational process assets that are essential for any defined process)

- Options that can be exercised and criteria for selecting among options
- Procedures that must be followed in performing and documenting process tailoring

Examples of reasons for tailoring include the following:

- Adapting the process for a new supplier
- Customizing the process for an application or class of similar applications
- Elaborating the process description so that the resulting defined process can be performed
- Accommodating supplier characteristics such as the number of projects executed for the acquirer and the supplier's process maturity
- Following the acquisition strategy

Flexibility in tailoring and defining processes is balanced with ensuring appropriate consistency of processes across the organization. Flexibility is needed to address contextual variables such as the domain; nature of the customer; cost, schedule, and quality tradeoffs; technical difficulty of the work; and experience of the people implementing the process. Consistency across the organization is needed so that organizational standards, objectives, and strategies are appropriately addressed, and process data and lessons learned can be shared.

Tailoring is a critical activity that allows controlled changes to processes due to the specific needs of a project or a part of the organization. Processes and process elements that are directly related to critical business goals and objectives should usually be defined as mandatory (allowing less variation), but processes and process elements that are less critical or only indirectly affect business objectives may allow for more tailoring (and therefore more variation). The amount of tailoring could also depend on the project's lifecycle model, the supplier, or the acquirer-supplier relationship.

Tailoring criteria and guidelines may allow for using a standard process "as is," with no tailoring.

Typical Work Products

1. Tailoring guidelines for the organization's set of standard processes

Subpractices

1. Specify selection criteria and procedures for tailoring the organization's set of standard processes.

To fully leverage the supplier's process capability, the acquirer may choose to minimize the tailoring of the supplier's standard processes. Depending on the interfaces of the acquirer's processes with the supplier's processes, the acquirer's standard processes may be tailored to allow the supplier to execute its standard processes.

Examples of criteria and procedures include the following:

- Criteria for selecting lifecycle models from those approved by the organization
- Criteria for selecting process elements from the organization's set of standard processes
- Procedures for tailoring selected lifecycle models and process elements to accommodate process characteristics and needs
- Criteria for selecting an acquisition strategy and suppliers
- Criteria for selecting acquirer processes based on supplier process tailoring such as adding or combining testing cycles

Examples of tailoring include the following:

- Modifying a lifecycle model
- Combining elements of different lifecycle models
- Modifying process elements
- Replacing process elements
- Reordering process elements

2. Specify the standards used for documenting defined processes.
3. Specify the procedures used for submitting and obtaining approval of waivers from requirements of the organization's set of standard processes.
4. Document tailoring guidelines for the organization's set of standard processes.
5. Conduct peer reviews on the tailoring guidelines.
6. Revise tailoring guidelines as necessary.

SP 1.4 Establish the Organization's Measurement Repository

Establish and maintain the organization's measurement repository.

Refer to the Use Organizational Process Assets for Planning Project Activities specific practice of the Integrated Project Management process area for more information about the use of the organization's measurement repository in planning project activities.

The repository contains both product and process measures related to the organization's set of standard processes. It also contains or refers to information needed to understand and interpret measures and to assess them for reasonableness and applicability. For example, the definitions of measures are used to compare similar measures from different processes.

Standard measures that must be collected from the supplier are included as requirements in standard supplier agreements and may appear in the organization's measurement repository.

Typical Work Products

1. Definition of the common set of product and process measures for the organization's set of standard processes
2. Design of the organization's measurement repository
3. Organization's measurement repository (i.e., the repository structure and support environment)
4. Organization's measurement data

Subpractices

1. Determine the organization's needs for storing, retrieving, and analyzing measurements.
2. Define a common set of process and product measures for the organization's set of standard processes.

Measures in the common set are selected based on the organization's set of standard processes. They are selected for their ability to provide visibility into process performance and to support expected business objectives. The common set of measures may vary for different standard processes.

Standard measures are selected for their ability to provide visibility into processes critical to expected business objectives and to focus on elements significantly impacting performance within a project and across the organization.

Measures defined include those related to agreement management, some of which may need to be collected from suppliers.

Operational definitions for measures specify procedures for collecting valid data and the point in the process where data will be collected.

Refer to the Measurement and Analysis process area for more information about defining measures.

3. Design and implement the measurement repository.
4. Specify procedures for storing, updating, and retrieving measures.

5. Conduct peer reviews on definitions of the common set of measures and procedures for storing, updating, and retrieving measures.
6. Enter specified measures into the repository.

Refer to the Measurement and Analysis process area for more information about collecting and analyzing data.

7. Make the contents of the measurement repository available for use by the organization and projects, as appropriate.
8. Revise the measurement repository, the common set of measures, and procedures as the organization's needs change.

Examples of when the common set of measures may need to be revised include the following:

- New processes are added
- Processes are revised and new measures are needed
- Finer granularity of data is required
- Greater visibility into the process is required
- Measures are retired

SP 1.5 Establish the Organization's Process Asset Library

Establish and maintain the organization's process asset library.

Examples of items to be stored in the organization's process asset library include the following:

- Organizational policies
- Defined process descriptions
- Procedures (e.g., estimating procedure)
- Development plans
- Acquisition plans
- Quality assurance plans
- Training materials
- Process aids (e.g., checklists)
- Lessons-learned reports

Typical Work Products

1. Design of the organization's process asset library
2. The organization's process asset library

3. Selected items to be included in the organization's process asset library
4. The catalog of items in the organization's process asset library

Subpractices

1. Design and implement the organization's process asset library, including the library structure and support environment.
2. Specify criteria for including items in the library.

Items are selected based primarily on their relationship to the organization's set of standard processes.
3. Specify procedures for storing, updating, and retrieving items.
4. Enter selected items into the library and catalog them for easy reference and retrieval.
5. Make items available for use by projects.
6. Periodically review the use of each item and use results to maintain the library contents.
7. Revise the organization's process asset library as necessary.

Examples of when the library may need to be revised include the following:

- New items are added
- Items are retired
- Current versions of items are changed

SP 1.6 Establish Work Environment Standards

Establish and maintain work environment standards.

Work environment standards allow the organization and projects to benefit from common tools, training, and maintenance, as well as cost savings from volume purchases. Work environment standards address the needs of all stakeholders and consider productivity, cost, availability, security, and workplace health, safety, and ergonomic factors. Work environment standards can include guidelines for tailoring and the use of waivers that allow adaptation of the project's work environment to meet needs.

Examples of work environment standards include the following:

- Procedures for the operation, safety, and security of the work environment
- Standard workstation hardware and software
- Standard application software and tailoring guidelines for it
- Standard production and calibration equipment
- Process for requesting and approving tailoring or waivers

Typical Work Products

1. Work environment standards

Subpractices

1. Evaluate commercially available work environment standards appropriate for the organization.
2. Adopt existing work environment standards and develop new ones to fill gaps based on the organization's process needs and objectives.

SP 1.7 Establish Rules and Guidelines for Integrated Teams

Establish and maintain organizational rules and guidelines for the structure, formation, and operation of integrated teams.

In an acquisition organization, integrated teams are useful not just in the acquirer's organization but between the acquirer and supplier and among the acquirer, supplier, and other relevant stakeholders, as appropriate. Integrated teaming may be especially important in a system of systems environment.

Operating rules and guidelines for integrated teams define and control how teams are created and how they interact to accomplish objectives. Integrated team members must understand the standards for work and participate according to those standards.

Structuring integrated teams involves defining the number of teams, the type of each team, and how each team relates with the others in the structure. Forming integrated teams involves chartering each team, assigning team members and team leaders, and providing resources to each team to accomplish its work.

Typical Work Products

1. Rules and guidelines for structuring and forming integrated teams

Subpractices

1. Establish and maintain empowerment mechanisms to enable timely decision making.

In a successful teaming environment, clear channels of responsibility and authority must be established. Issues can arise at any level of the organization when integrated teams assume too much or too little authority and when it is unclear who is responsible for making decisions. Documenting and deploying organizational guidelines that clearly define the empowerment of integrated teams can prevent these issues.

2. Establish rules and guidelines for structuring and forming integrated teams.

Organizational process assets can help the project to structure and implement integrated teams. Such assets may include the following:

- Team structure guidelines
- Team formation guidelines
- Team authority and responsibility guidelines
- Guidelines for establishing lines of communication and authority
- Team leader selection criteria

3. Define the expectations, rules, and guidelines that guide how integrated teams work collectively.

These rules and guidelines establish organizational practices for consistency across integrated teams and can include the following:

- How interfaces among integrated teams are established and maintained
- How assignments are accepted
- How resources and inputs are accessed
- How work gets done
- Who checks, reviews, and approves work
- How work is approved
- How work is delivered and communicated
- Reporting chains
- Reporting requirements (e.g., cost, schedule, and performance status), measures, and methods
- Progress reporting measures and methods

4. Maintain the rules and guidelines for structuring and forming integrated teams.

5. Establish and maintain organizational guidelines to help team members balance their team and home organization responsibilities.

A *home organization* is the part of the organization to which team members are assigned when they are not on an integrated team. A *home organization* may be called a *functional organization*, *home base*, *home office*, or *direct organization*.

ORGANIZATIONAL PROCESS FOCUS

A Process Management Process Area at Maturity Level 3

Purpose

The purpose of Organizational Process Focus (OPF) is to plan, implement, and deploy organizational process improvements based on a thorough understanding of current strengths and weaknesses of the organization's processes and process assets.

Introductory Notes

The organization's processes include all processes used by the organization and its projects. Candidate improvements to the organization's processes and process assets are obtained from various sources, including the measurement of processes, lessons learned in implementing processes, results of process appraisals, results of product evaluation activities, results of benchmarking against other organizations' processes, and recommendations from other improvement initiatives in the organization.

Process improvement occurs in the context of the organization's needs and is used to address the organization's objectives. The organization encourages participation in process improvement activities by those who perform the process. The responsibility for facilitating and managing the organization's process improvement activities, including coordinating the participation of others, is typically assigned to a process group. The organization provides the long-term commitment and resources required to sponsor this group and to ensure the effective and timely deployment of improvements.

The acquirer encourages supplier participation in process improvement activities.

Careful planning is required to ensure that process improvement efforts across the organization are adequately managed and implemented. The organization's process improvement planning results in a process improvement plan.

The organization's process improvement plan addresses appraisal planning, process action planning, pilot planning, and deployment planning. Appraisal plans describe the appraisal timeline and schedule, the scope of the appraisal, resources required to perform the appraisal, the reference model against which the appraisal will be performed, and logistics for the appraisal.

Process action plans usually result from appraisals and document how improvements targeting weaknesses uncovered by an appraisal will be implemented. Sometimes the improvement described in the process action plan should be tested on a small group before deploying it across the organization. In these cases, a pilot plan is generated.

Finally, when the improvement is to be deployed, a deployment plan is created. This plan describes when and how the improvement will be deployed across the organization.

Organizational process assets are used to describe, implement, and improve the organization's processes (see the definition of "organizational process assets" in the glossary).

Related Process Areas

Refer to the Organizational Process Definition process area for more information about organizational process assets.

Refer to the Organizational Training process area for more information about the coordination of training.

Refer to the Measurement and Analysis process area for more information about analyzing measures.

Specific Goal and Practice Summary

SG 1 Determine Process Improvement Opportunities

- SP 1.1 Establish Organizational Process Needs
- SP 1.2 Appraise the Organization's Processes
- SP 1.3 Identify the Organization's Process Improvements

SG 2 Plan and Implement Process Actions

- SP 2.1 Establish Process Action Plans
- SP 2.2 Implement Process Action Plans

SG 3 Deploy Organizational Process Assets and Incorporate Experiences

- SP 3.1 Deploy Organizational Process Assets
- SP 3.2 Deploy Standard Processes
- SP 3.3 Monitor the Implementation
- SP 3.4 Incorporate Experiences into Organizational Process Assets

Specific Practices by Goal

SG 1 Determine Process Improvement Opportunities

Strengths, weaknesses, and improvement opportunities for the organization's processes are identified periodically and as needed.

Strengths, weaknesses, and improvement opportunities may be determined relative to a process standard or model such as a CMMI model or International Organization for Standardization (ISO) standard. Process improvements should be selected to address the organization's needs.

Changing business objectives, legal and regulatory requirements, and results of benchmarking studies may be sources of process improvement opportunities.

SP 1.1 Establish Organizational Process Needs

Establish and maintain the description of process needs and objectives for the organization.

The organization's processes operate in a business context that must be understood. The organization's business objectives, needs, and constraints determine the needs and objectives for the organization's processes. Typically, issues related to finance, technology, quality, human resources, and marketing are important process considerations.

The organization's process needs and objectives cover aspects that include the following:

- Characteristics of processes
- Process-performance objectives, such as time-to-market and delivered quality
- Process effectiveness

Issues related to the organization's acquisition management needs are important process considerations.

Typical Work Products

1. The organization's process needs and objectives

Subpractices

1. Identify policies, standards, and business objectives that are applicable to the organization's processes.
2. Examine relevant process standards and models for best practices.
3. Determine the organization's process-performance objectives.

Process-performance objectives may be expressed in quantitative or qualitative terms.

Refer to the Measurement and Analysis process area for more information about establishing measurement objectives.

Examples of process-performance objectives include the following:

- Cycle time
- Defect removal rates
- Productivity

4. Define essential characteristics of the organization's processes.

Essential characteristics of the organization's processes are determined based on the following:

- Processes currently being used in the organization
- Standards imposed by the organization
- Standards commonly imposed by customers of the organization

Examples of process characteristics include the following:

- Level of detail used to describe processes
- Process notation used
- Granularity of processes

5. Document the organization's process needs and objectives.

6. Revise the organization's process needs and objectives as needed.

SP 1.2 Appraise the Organization's Processes

Appraise the organization's processes periodically and as needed to maintain an understanding of their strengths and weaknesses.

Process appraisals may be performed for the following reasons:

- To identify processes to be improved
- To confirm progress and make the benefits of process improvement visible
- To satisfy the needs of a customer-supplier relationship
- To motivate and facilitate buy-in

The buy-in gained during a process appraisal can be eroded significantly if it is not followed by an appraisal-based action plan.

Typical Work Products

1. Plans for the organization's process appraisals
2. Appraisal findings that address strengths and weaknesses of the organization's processes
3. Improvement recommendations for the organization's processes

Subpractices

1. Obtain sponsorship of the process appraisal from senior management.

Senior management sponsorship includes the commitment to have the organization's managers and staff participate in the process appraisal and to provide resources and funding to analyze and communicate findings of the appraisal.

2. Define the scope of the process appraisal.

Process appraisals may be performed on the entire organization or may be performed on a smaller part of an organization such as a single project or business area.

The scope of the process appraisal addresses the following:

- Definition of the organization (e.g., sites or business areas) to be covered by the appraisal
- Identification of the project and support functions that will represent the organization in the appraisal
- Processes to be appraised

3. Determine the method and criteria for the process appraisal.

Process appraisals can occur in many forms. They should address the needs and objectives of the organization, which may change over time. For example, the appraisal may be based on a process model, such as a CMMI model, or on a national or international standard, such as ISO 9001 [ISO 2000]. Appraisals may also be based on a benchmark comparison with other organizations in which practices that may contribute to improved performance are identified. The appraisal method may assume a variety of characteristics, including time and effort, makeup of the appraisal team, and the method and depth of investigation.

4. Plan, schedule, and prepare for the process appraisal.
5. Conduct the process appraisal.
6. Document and deliver the appraisal's activities and findings.

SP 1.3

Identify the Organization's Process Improvements

Identify improvements to the organization's processes and process assets.

Typical Work Products

1. Analysis of candidate process improvements
2. Identification of improvements for the organization's processes

Subpractices

1. Determine candidate process improvements.

Candidate process improvements are typically determined by doing the following:

- Measure processes and analyze measurement results
- Review processes for effectiveness and suitability
- Review lessons learned from tailoring the organization's set of standard processes
- Review lessons learned from implementing processes
- Review process improvement proposals submitted by the organization's managers, staff, and other relevant stakeholders
- Solicit inputs on process improvements from senior management and other leaders in the organization
- Examine results of process appraisals and other process-related reviews
- Review results of other organizational improvement initiatives

Candidate process improvements are also determined by doing the following:

- Reviewing process improvement proposals submitted by the organization's suppliers
- Obtaining feedback from suppliers on acquirer processes and supplier-acquirer interface points

2. Prioritize candidate process improvements.

Examples of techniques to help determine and prioritize possible improvements to be implemented include the following:

- A cost-benefit analysis that compares the estimated cost and effort to implement the process improvements and their associated benefits
- A gap analysis that compares current conditions in the organization with optimal conditions
- Force-field analysis of potential improvements to identify potential barriers and strategies for overcoming those barriers
- Cause-and-effect analyses to provide information on the potential effects of different improvements that can then be compared

3. Identify and document the process improvements to be implemented.
4. Revise the list of planned process improvements to keep it current.

SG 2 Plan and Implement Process Actions

Process actions that address improvements to the organization's processes and process assets are planned and implemented.

The successful implementation of improvements requires participation in process action planning and implementation by process owners, those performing the process, and support organizations.

SP 2.1 Establish Process Action Plans

Establish and maintain process action plans to address improvements to the organization's processes and process assets.

Establishing and maintaining process action plans typically involves the following roles:

- Management steering committees to set strategies and oversee process improvement activities
- Process groups to facilitate and manage process improvement activities
- Process action teams to define and implement process actions
- Process owners to manage deployment
- Practitioners to perform the process

This involvement helps to obtain buy-in on process improvements and increases the likelihood of effective deployment.

Process action plans are detailed implementation plans. These plans differ from the organization's process improvement plan by targeting improvements that were defined to address weaknesses, usually uncovered by appraisals.

Suppliers may be involved in developing process action plans if the processes that define interfaces between the acquirer and supplier are targeted for improvement.

Typical Work Products

1. The organization's approved process action plans

Subpractices

1. Identify strategies, approaches, and actions to address identified process improvements.

New, unproven, and major changes are piloted before they are incorporated into normal use.

2. Establish process action teams to implement actions.

Process action teams typically include process owners and those who perform the process. Process action teams may also include supplier representatives when suppliers interact with the acquirer process to be improved or provide supplemental resources to the acquirer to perform an acquirer process.

3. Document process action plans.

Process action plans typically cover the following:

- The process improvement infrastructure
- Process improvement objectives
- Process improvements to be addressed
- Procedures for planning and tracking process actions
- Strategies for piloting and implementing process actions
- Responsibility and authority for implementing process actions
- Resources, schedules, and assignments for implementing process actions
- Methods for determining the effectiveness of process actions
- Risks associated with process action plans

4. Review and negotiate process action plans with relevant stakeholders.

5. Review process action plans as necessary.

SP 2.2 Implement Process Action Plans

Implement process action plans.

Typical Work Products

1. Commitments among process action teams
2. Status and results of implementing process action plans
3. Plans for pilots

Subpractices

1. Make process action plans readily available to relevant stakeholders.
2. Negotiate and document commitments among process action teams and revise their process action plans as necessary.
3. Track progress and commitments against process action plans.

4. Conduct joint reviews with process action teams and relevant stakeholders to monitor the progress and results of process actions.
5. Plan pilots needed to test selected process improvements.
6. Review the activities and work products of process action teams.
7. Identify, document, and track to closure issues encountered when implementing process action plans.
8. Ensure that results of implementing process action plans satisfy the organization's process improvement objectives.

SG 3

Deploy Organizational Process Assets and Incorporate Experiences

The organizational process assets are deployed across the organization and process-related experiences are incorporated into organizational process assets.

The specific practices under this specific goal describe ongoing activities. New opportunities to benefit from organizational process assets and changes to them may arise throughout the life of each project. Deployment of standard processes and other organizational process assets must be continually supported in the organization, particularly for new projects at startup.

SP 3.1

Deploy Organizational Process Assets

Deploy organizational process assets across the organization.

Deploying organizational process assets or changes to them should be performed in an orderly manner. Some organizational process assets or changes to them may not be appropriate for use in some parts of the organization (e.g., because of customer requirements or the current lifecycle phase being implemented). It is therefore important that those that are or will be executing the process, as well as other organization functions (e.g., training and quality assurance), be involved in the deployment as necessary.

Refer to the Organizational Process Definition process area for more information about how the deployment of organizational process assets is supported and enabled by the organization's process asset library.

Typical Work Products

1. Plans for deploying organizational process assets and changes to them across the organization
2. Training materials for deploying organizational process assets and changes to them
3. Documentation of changes to organizational process assets

4. Support materials for deploying organizational process assets and changes to them

Subpractices

1. Deploy organizational process assets across the organization.

Typical activities performed as a part of this deployment include the following:

- Identifying organizational process assets that should be adopted by those who perform the process
- Determining how organizational process assets are made available (e.g., via a Web site)
- Identifying how changes to organizational process assets are communicated
- Identifying resources (e.g., methods and tools) needed to support the use of organizational process assets
- Planning the deployment
- Assisting those who use organizational process assets
- Ensuring that training is available for those who use organizational process assets

Refer to the Organizational Training process area for more information about the coordination of training.

2. Document changes to organizational process assets.

Documenting changes to organizational process assets serves two main purposes:

- To enable the communication of changes.
- To understand the relationship of changes in the organizational process assets to changes in process performance and results.

3. Deploy changes that were made to organizational process assets across the organization.

Typical activities performed as a part of deploying changes include the following:

- Determining which changes are appropriate for those who perform the process
- Planning the deployment
- Arranging for the support needed to successfully transition changes

4. Provide guidance and consultation on the use of organizational process assets.

SP 3.2 Deploy Standard Processes

Deploy the organization's set of standard processes to projects at their startup and deploy changes to them, as appropriate, throughout the life of each project.

It is important that new projects use proven and effective processes to perform critical early activities (e.g., project planning, receiving requirements, and obtaining resources).

Projects should also periodically update their defined processes to incorporate the latest changes made to the organization's set of standard processes when it will benefit them. This periodic update helps to ensure that all project activities derive the full benefit of what other projects have learned.

Refer to the Organizational Process Definition process area for more information about the organization's set of standard processes and tailoring guidelines.

Typical Work Products

1. The organization's list of projects and the status of process deployment on each (i.e., existing and planned projects)
2. Guidelines for deploying the organization's set of standard processes on new projects
3. Records of tailoring and implementing the organization's set of standard processes

Subpractices

1. Identify projects in the organization that are starting up.
2. Identify active projects that would benefit from implementing the organization's current set of standard processes.
3. Establish plans to implement the organization's current set of standard processes on the identified projects.
4. Assist projects in tailoring the organization's set of standard processes to meet their needs.

Refer to the Integrated Project Management process area for more information about tailoring the organization's set of standard processes to meet the unique needs and objectives of the project.

5. Maintain records of tailoring and implementing processes on the identified projects.
6. Ensure that the defined processes resulting from process tailoring are incorporated into plans for process-compliance audits.

Process-compliance audits are objective evaluations of project activities against the project's defined process.

7. As the organization's set of standard processes are updated, identify which projects should implement the changes.

SP 3.3 Monitor the Implementation

Monitor the implementation of the organization's set of standard processes and use of process assets on all projects.

By monitoring implementation, the organization ensures that the organization's set of standard processes and other process assets are appropriately deployed to all projects. Monitoring implementation also helps the organization develop an understanding of the organizational process assets being used and where they are used in the organization. Monitoring also helps to establish a broader context for interpreting and using process and product measures, lessons learned, and improvement information obtained from projects.

Typical Work Products

1. Results of monitoring process implementation on projects
2. Status and results of process-compliance audits
3. Results of reviewing selected process artifacts created as part of process tailoring and implementation

Subpractices

1. Monitor projects for their use of the organization's process assets and changes to them.
2. Review selected process artifacts created during the life of each project.

Reviewing selected process artifacts created during the life of a project ensures that all projects are making appropriate use of the organization's set of standard processes.

3. Review results of process-compliance audits to determine how well the organization's set of standard processes has been deployed.

Refer to the Process and Product Quality Assurance process area for more information about objectively evaluating processes against applicable process descriptions, standards, and procedures.

4. Identify, document, and track to closure issues related to implementing the organization's set of standard processes.

SP 3.4 Incorporate Experiences into Organizational Process Assets

Incorporate process-related work products, measures, and improvement information derived from planning and performing the process into organizational process assets.

Typical Work Products

1. Process improvement proposals
2. Process lessons learned
3. Measurements of organizational process assets
4. Improvement recommendations for organizational process assets
5. Records of the organization's process improvement activities
6. Information on organizational process assets and improvements to them

Subpractices

1. Conduct periodic reviews of the effectiveness and suitability of the organization's set of standard processes and related organizational process assets relative to the organization's business objectives.
2. Obtain feedback about the use of organizational process assets.
3. Derive lessons learned from defining, piloting, implementing, and deploying organizational process assets.
4. Make lessons learned available to people in the organization, as appropriate.

Actions may be necessary to ensure that lessons learned are used appropriately.

Examples of inappropriate use of lessons learned include the following:

- Evaluating the performance of people
- Judging process performance or results

Examples of ways to prevent inappropriate use of lessons learned include the following:

- Controlling access to lessons learned
- Educating people about the appropriate use of lessons learned

5. Analyze the organization's common set of measures.

Refer to the Measurement and Analysis process area for more information about analyzing measures.

Refer to the Organizational Process Definition process area for more information about establishing an organizational measurement repository, including common measures.

6. Appraise processes, methods, and tools in use in the organization and develop recommendations for improving organizational process assets.

This appraisal typically includes the following:

- Determining which processes, methods, and tools are of potential use to other parts of the organization
- Appraising the quality and effectiveness of organizational process assets
- Identifying candidate improvements to organizational process assets
- Determining compliance with the organization's set of standard processes and tailoring guidelines

7. Make the best of the organization's processes, methods, and tools available to people in the organization, as appropriate.
8. Manage process improvement proposals.

Process improvement proposals can address both process and technology improvements.

The activities for managing process improvement proposals typically include the following:

- Soliciting process improvement proposals
- Collecting process improvement proposals
- Reviewing process improvement proposals
- Selecting the process improvement proposals to be implemented
- Tracking the implementation of process improvement proposals

Process improvement proposals are documented as process change requests or problem reports, as appropriate.

Some process improvement proposals may be incorporated into the organization's process action plans.

9. Establish and maintain records of the organization's process improvement activities.

ORGANIZATIONAL PROCESS PERFORMANCE

A Process Management Process Area at Maturity Level 4

Purpose

The purpose of Organizational Process Performance (OPP) is to establish and maintain a quantitative understanding of the performance of the organization's set of standard processes in support of achieving quality and process-performance objectives, and to provide process-performance data, baselines, and models to quantitatively manage the organization's projects.

Introductory Notes

Process performance is a measure of actual results achieved by following a process. Process performance is characterized by process measures (e.g., effort, cycle time, and defect removal effectiveness) and product measures (e.g., reliability, defect density, capacity, response time, and cost).

The common measures for the organization consist of process and product measures that can be used to characterize the actual performance of processes in the organization's individual projects. By analyzing the resulting measurements, a distribution or range of results can be established that characterize the expected performance of the process when used on any individual project.

In this process area, the phrase *quality and process-performance objectives* covers objectives and requirements for product quality, service quality, and process performance. As indicated above, the term *process performance* includes quality; however, to emphasize the importance of quality, the phrase *quality and process-performance objectives* is used rather than just *process-performance objectives*.

Measuring quality and process performance may involve combining existing measures into additional derived measures to provide more insight into the overall efficiencies and effectiveness at a project or organization level. The analysis at the organization level may be used to study productivity, improve efficiencies, and increase throughput across projects in the organization.

The expected process performance can be used in establishing the project's quality and process-performance objectives and can be used as a baseline against which actual project performance can be compared. This information is used to quantitatively manage the project. Each quantitatively managed project, in turn, provides actual performance results that become a part of baseline data for organizational process assets.

The acquirer may use quality and process-performance objectives to define performance and service level expectations for suppliers.

Process-performance models are used to represent past and current process performance and to predict future results of the process. For example, the latent defects in the delivered product can be predicted using measurements of defects identified during product verification activities.

The same measures of latent defects, analyzed using a supplier's past projects data, can be used to predict the quality of products delivered by that supplier. The acquirer can use supplier process-performance models to predict the overall capability of the acquirer to deliver the product.

When the organization has measures, data, and analytical techniques for critical process, product, and service characteristics, it is able to do the following:

- Determine whether processes are behaving consistently or have stable trends (i.e., are predictable)
- Identify processes in which performance is within natural bounds that are consistent across process implementation teams
- Establish criteria for identifying whether a process or subprocess should be statistically managed, and determine pertinent measures and analytical techniques to be used in such management
- Identify processes that show unusual (e.g., sporadic or unpredictable) behavior
- Identify aspects of processes that can be improved in the organization's set of standard processes
- Identify the implementation of a process that performs best
- Identify aspects of processes that could be improved across acquirer-supplier interfaces

Related Process Areas

Refer to the Quantitative Project Management process area for more information about the use of process-performance baselines and models.

Refer to the Measurement and Analysis process area for more information about specifying measures and collecting and analyzing data.

Refer to the Organizational Process Definition process area for more information about establishing organizational process assets.

Specific Goal and Practice Summary

SG 1 Establish Performance Baselines and Models

- SP 1.1 Select Processes
- SP 1.2 Establish Process-Performance Measures
- SP 1.3 Establish Quality and Process-Performance Objectives
- SP 1.4 Establish Process-Performance Baselines
- SP 1.5 Establish Process-Performance Models

Specific Practices by Goal

SG 1 Establish Performance Baselines and Models

Baselines and models, which characterize the expected process performance of the organization's set of standard processes, are established and maintained.

Prior to establishing process-performance baselines and models, it is necessary to determine which processes are suitable to be measured (the Select Processes specific practice), which measures are useful for determining process performance (the Establish Process-Performance Measures specific practice), and the quality and process-performance objectives for those processes (the Establish Quality and Process-Performance Objectives specific practice).

These specific practices are often interrelated and may need to be performed concurrently to select appropriate processes, measures, and quality and process-performance objectives. Often, the selection of one process, measure, or objective will constrain the selection of the others. For example, if a certain process is selected, the measures and objectives for that process may be constrained by the process itself.

SP 1.1

Select Processes

Select processes or subprocesses in the organization's set of standard processes to be included in the organization's process-performance analyses.

Refer to the *Organizational Process Definition* process area for more information about the structure of organizational process assets.

The organization's set of standard processes consists of a set of standard processes that, in turn, are composed of subprocesses.

Typically, it will not be possible, useful, or economically justifiable to apply statistical management techniques to all processes or subprocesses of the organization's set of standard processes. Selection of processes or subprocesses is based on the needs and objectives of both the organization and its projects.

The selection of subprocesses for analysis, the determination of process-performance objectives, and the selection of appropriate measures are often concurrent and iterative processes of both the organization and its projects.

When selecting processes or subprocesses for analyses, it is critical to understand the relationships between different processes and subprocesses and their impact on the acquirer and supplier delivering the product specified by the customer. Such an approach helps to ensure that quantitative and statistical management are applied where they have the most overall value to the organization.

Examples of criteria that may be used for the selection of a process or subprocess for the organization's process-performance analysis include the following:

- The relationship of the subprocess to key business objectives
- Current availability of valid historical data relevant to the subprocess
- Current degree of data variability
- Subprocess stability (e.g., stable performance in comparable instances)
- The availability of corporate or commercial information that can be used to build predictive models

The existence of project data that indicates the process or subprocess has been or can be stabilized is a useful criterion that can be used for selecting a process or subprocess.

Typical Work Products

1. List of processes or subprocesses identified for process-performance analyses

SP 1.2 Establish Process-Performance Measures

Establish and maintain definitions of measures to be included in the organization's process-performance analyses.

Refer to the Measurement and Analysis process area for more information about specifying measures.

Typical Work Products

1. Definitions of selected measures of process performance

Subpractices

1. Determine which of the organization's business objectives for quality and process performance should be addressed by the measures.
2. Select measures that provide appropriate insight into the organization's quality and process performance.

The measurement repository provides common measures for this purpose.

For business objectives addressed through acquisition, select process, product, and service level measures that provide insight into the process performance of suppliers and into the quality of their deliverables.

Examples of criteria used to select measures include the following:

- Relationship of measures to the organization's business objectives
- Coverage that measures provide over the life of the product or service
- Visibility that measures provide into process performance
- Availability of measures
- Extent to which measures are objective
- Frequency at which observations of the measure can be collected
- Extent to which measures are controllable by changes to the process or subprocess
- Extent to which measures represent the users' view of effective process performance
- Extent to which measures provide insight that enables the acquirer to manage the project

3. Incorporate selected measures into the organization's set of common measures.

Measures expected to be collected and reported by suppliers are incorporated into standard supplier agreement templates and standard service level agreements, as appropriate.

4. Revise the set of measures as necessary.

Measures are periodically evaluated for their continued usefulness and ability to indicate process effectiveness.

SP 1.3

Establish Quality and Process-Performance Objectives

Establish and maintain the organization's quantitative objectives for quality and process performance.

The organization's quality and process-performance objectives should have the following attributes:

- Based on the organization's business objectives
- Based on the past performance of projects
- Gauges process performance in areas such as product quality, productivity, cycle time, or response time
- Accounts for the inherent variability or natural bounds of the selected process or subprocess
- Accounts for the inherent variability or natural bounds of supplier performance

Typical Work Products

1. The organization's quality and process-performance objectives
2. Supplier service levels based on quality and process-performance objectives

Subpractices

1. Review the organization's business objectives related to quality and process performance.

Examples of business objectives include the following:

- Achieve a development cycle of a specified duration for a specified release of a product
- Deliver the functionality of the product for a target percentage of estimated cost
- Decrease the cost of product maintenance by a specified percent

2. Define the organization's quantitative objectives for quality and process performance.

Objectives may be established for process or subprocess measurements (e.g., effort, cycle time, and defect removal effectiveness) as well as for product measurements (e.g., reliability and defect density) and service measurements (e.g., capacity and response times) as appropriate.

Examples of quality and process-performance objectives include the following:

- Achieve a specified productivity
- Deliver work products with no more than a specified number of latent defects
- Shorten time to delivery within +/- 5 percent of the process-performance baseline
- Reduce total lifecycle cost of new and existing products by 15 percent
- Deliver 100 percent of the specified functionality of the product
- Improve supplier performance and relationship scores to 4.8 (out of 5)

3. Define the priorities of the organization's objectives for quality and process performance.
4. Review, negotiate, and obtain commitment to the organization's quality and process-performance objectives and their priorities from relevant stakeholders.
5. Revise the organization's quantitative objectives for quality and process performance as necessary.

Examples of when the organization's quantitative objectives for quality and process performance may need to be revised include the following:

- When the organization's business objectives change
- When the organization's processes change
- When actual quality and process performance differs significantly from the objectives

SP 1.4 Establish Process-Performance Baselines

Establish and maintain the organization's process-performance baselines.

The organization's process-performance baselines are a measurement of performance for the organization's set of standard processes at various levels of detail, as appropriate. The processes include the following:

- Sequence of connected processes
- Processes that cover the entire life of the project
- Processes for developing individual work products

There may be several process-performance baselines to characterize performance for subgroups of the organization.

Examples of criteria used to categorize subgroups include the following:

- Product line
- Line of business
- Application domain
- Complexity
- Team size
- Work product size
- Process elements from the organization's set of standard processes
- Supplier-acquisition approach
- Agreement type (e.g., fixed price and time and effort)

Tailoring of the organization's set of standard processes may significantly affect the comparability of data for inclusion in process-performance baselines. Effects of tailoring should be considered in establishing baselines. Depending on the tailoring allowed, separate performance baselines may exist for each type of tailoring.

Refer to the Quantitative Project Management process area for more information about the use of process-performance baselines.

Typical Work Products

1. Baseline data on the organization's process performance

Subpractices

1. Collect measurements from the organization's projects.

The process or subprocess in use when the measurement was taken is recorded to enable appropriate use later.

Refer to the Measurement and Analysis process area for more information about collecting and analyzing data.

2. Establish and maintain the organization's process-performance baselines from collected measurements and analyses.

Refer to the Measurement and Analysis process area for more information about establishing objectives for measurement and analysis, specifying measures and analyses to be performed, obtaining and analyzing measures, and reporting results.

Process-performance baselines are derived by analyzing collected measurements to establish a distribution or range of results that characterize the expected performance for selected processes or subprocesses when used on a project in the organization.

The measurements from stable subprocesses in projects should be used when possible; other data may not be reliable.

3. Review and get agreement with relevant stakeholders about the organization's process-performance baselines.
4. Make the organization's process-performance information available across the organization in the organization's measurement repository.

The organization's process-performance baselines are used by projects to estimate the natural bounds for process performance.

5. Compare the organization's process-performance baselines to associated objectives.
6. Revise the organization's process-performance baselines as necessary.

Examples of when the organization's process-performance baselines may need to be revised include the following:

- When the processes change
- When the organization's results change
- When the organization's needs change
- When suppliers processes change
- When suppliers change

SP 1.5 Establish Process-Performance Models

Establish and maintain process-performance models for the organization's set of standard processes.

Process-performance models are used to estimate or predict the value of a process-performance measure from the values of other process, product, and service measurements. These process-performance models typically use process and product measurements collected throughout the life of the project to estimate progress toward achieving objectives that cannot be measured until later in the project's life.

Process-performance models are used to estimate or predict when to fund, hold, cancel, migrate, re-engineer, or retire a project. Process-performance models allow the acquirer to synchronize processes with customer needs. The organization's process-performance baselines provide quantitative data on those aspects of the projects and organization that can approximate the throughput potential of its processes. Focusing on these critical constraints, process-performance models allow the acquirer to predict how to best maximize the flow of work through projects and the organization.

Process-performance models are used as follows:

- The organization uses them for estimating, analyzing, and predicting the process performance associated with processes in and changes to the organization's set of standard processes.
- The organization uses them to assess the (potential) return on investment for process improvement activities.
- Projects use them for estimating, analyzing, and predicting the process performance of their defined processes.
- Projects use them for selecting processes or subprocesses for use.

Process-performance models are also used to set process-performance objectives for suppliers and to provide data that can help suppliers achieve these objectives.

These measures and models are defined to provide insight into and to provide the ability to predict critical process and product characteristics that are relevant to business value.

Results of the acquirer's process-performance models are shared with suppliers to help ensure the synchronized delivery of products and services.

Examples of areas of concern to projects in which models may be useful include the following:

- Schedule and cost
- Reliability
- Defect identification and removal rates
- Defect removal effectiveness
- Latent defect estimation
- Response time
- Project progress
- Combinations of these areas

Examples of process-performance models include the following:

- System dynamics models
- Reliability growth models
- Complexity models
- Supply chain models

Refer to the Quantitative Project Management process area for more information about the use of process-performance models.

Typical Work Products

1. Process-performance models

Typical Supplier Deliverables

1. Supplier process-performance models

Subpractices

1. Establish process-performance models based on the organization's set of standard processes and the organization's process-performance baselines.
2. Calibrate process-performance models based on the organization's past results and current needs.
3. Review process-performance models and get agreement with relevant stakeholders.
4. Support the projects' use of the process-performance models.
5. Revise process-performance models as necessary.

Examples of when process-performance models may need to be revised include the following:

- When processes change
- When the organization's results change
- When the organization's needs change
- When supplier processes that directly interface with acquirer processes change
- When suppliers change

ORGANIZATIONAL TRAINING

A Process Management Process Area at Maturity Level 3

Purpose

The purpose of Organizational Training (OT) is to develop skills and knowledge of people so they can perform their roles effectively and efficiently.

Introductory Notes

Organizational Training includes training to support the organization's strategic business objectives and to meet the tactical training needs that are common across projects and support groups. Training needs identified by individual projects and support groups are handled at the project and support group level and are outside the scope of Organizational Training. Projects and support groups are responsible for identifying and addressing their training needs.

An organizational training program involves the following activities:

- Identifying the training needed by the organization
- Obtaining and providing training to address those needs
- Establishing and maintaining a training capability
- Establishing and maintaining training records
- Assessing training effectiveness

Effective training requires the assessment of needs, planning, instructional design, and appropriate training media (e.g., workbooks and computer software), as well as a repository of training process data. As an organizational process, the main components of training include a managed training development program, documented plans, personnel with appropriate mastery of disciplines and other areas of knowledge, and mechanisms for measuring the effectiveness of the training program.

Identifying process training needs is based primarily on the skills required to perform the organization's set of standard processes.

Identifying training needs may also address some training needs of suppliers, especially in those process elements that define interfaces with and expectations for suppliers.

Certain skills may be effectively and efficiently imparted through vehicles other than in-class training experiences (e.g., informal mentoring). Other skills require more formalized training vehicles, such as in a classroom, by Web-based training, through guided self-study, or via a formalized on-the-job training program. The formal or informal training vehicles employed for each situation should be based on an assessment of the need for training and the performance gap to be addressed. The term *training* used throughout this process area is used broadly to include all of these learning options.

Success in training can be measured by the availability of opportunities to acquire the skills and knowledge needed to perform new and ongoing enterprise activities.

Skills and knowledge may be technical, organizational, or contextual. Technical skills pertain to the ability to use equipment, tools, materials, data, and processes required by a project or process. Organizational skills pertain to behavior within and according to the employee's organization structure, role and responsibilities, and general operating principles and methods. Contextual skills are the self-management, communication, and interpersonal abilities needed to successfully perform in the organizational and social context of the project and support groups.

The phrase *project and support groups* is used frequently in the process area description to indicate an organization-level perspective.

This process area applies to developing acquirer skills and knowledge so that those in the organization can perform their roles effectively and efficiently. However, these practices can also apply to developing the supplier skills and knowledge. Topics can include acquirer business practices (e.g., acceptance and invoicing) as well as technical practices that the acquirer desires to be performed in a particular way (e.g., reflect lean thinking) or a collaborative way (e.g., using an agile approach).

Related Process Areas

Refer to the Organizational Process Definition process area for more information about the organization's process assets.

Refer to the Project Planning process area for more information about training needs identified by projects.

Refer to the Decision Analysis and Resolution process area for more information about applying evaluation criteria when selecting training approaches.

Specific Goal and Practice Summary

SG 1 Establish an Organizational Training Capability

- SP 1.1 Establish Strategic Training Needs
- SP 1.2 Determine Which Training Needs Are the Responsibility of the Organization
- SP 1.3 Establish an Organizational Training Tactical Plan
- SP 1.4 Establish a Training Capability

SG 2 Provide Necessary Training

- SP 2.1 Deliver Training
- SP 2.2 Establish Training Records
- SP 2.3 Assess Training Effectiveness

Specific Practices by Goal

SG 1 Establish an Organizational Training Capability

A training capability, which supports the organization's management and technical roles, is established and maintained.

The organization identifies training required to develop the skills and knowledge necessary to perform enterprise activities. Once the needs are identified, a training program addressing those needs is developed.

SP 1.1 Establish Strategic Training Needs

Establish and maintain strategic training needs of the organization.

Strategic training needs address long-term objectives to build a capability by filling significant knowledge gaps, introducing new technologies, or implementing major changes in behavior. Strategic planning typically looks two to five years into the future.

Examples of sources of strategic training needs include the following:

- The organization's standard processes
- The organization's strategic business plan
- The organization's process improvement plan
- Enterprise-level initiatives
- Skill assessments
- Risk analyses
- Acquisition and supplier management

Typical Work Products

1. Training needs
2. Assessment analysis

Subpractices

1. Analyze the organization's strategic business objectives and process improvement plan to identify potential training needs.
2. Document the strategic training needs of the organization.

Examples of categories of training needs include (but are not limited to) the following:

- Process analysis and documentation
- Engineering (e.g., requirements analysis, design, testing, configuration management, and quality assurance)
- Selection and management of suppliers
- Management (e.g., estimating, tracking, and risk management)
- Disaster recovery and continuity of operations
- Acquisition management (e.g., solicitation, supplier selection, and supplier management)
- Communication and negotiation skills

3. Determine the roles and skills needed to perform the organization's set of standard processes.

Roles may include project manager, architects, business process analysts and suppliers, especially in process elements that identify interfaces with and expectations from suppliers.

4. Document the training needed to perform roles in the organization's set of standard processes.
5. Document the training needed to maintain the safe, secure, and continued operation of the business.
6. Revise the organization's strategic needs and required training as necessary.

SP 1.2 Determine Which Training Needs Are the Responsibility of the Organization

Determine which training needs are the responsibility of the organization and which are left to the individual project or support group.

Refer to the Project Planning process area for more information about project- and support-group-specific plans for training.

In addition to strategic training needs, organizational training addresses training requirements that are common across projects and support groups. Projects and support groups have the primary responsibility for identifying and addressing their training needs. The organization's training staff is responsible only for addressing common cross-project and support group training needs (e.g., training in work environments common to multiple projects). In some cases, however, the organization's training staff may address additional training needs of projects and support groups, as negotiated with them, in the context of the training resources available and the organization's training priorities.

Typical Work Products

1. Common project and support group training needs
2. Training commitments

Subpractices

1. Analyze the training needs identified by projects and support groups.

Analysis of project and support group needs is intended to identify common training needs that can be most efficiently addressed organization-wide. These needs-analysis activities are used to anticipate future training needs that are first visible at the project and support group level.

2. Negotiate with projects and support groups on how their training needs will be satisfied.

The support provided by the organization's training staff depends on the training resources available and the organization's training priorities.

Examples of training appropriately performed by the project or support group include the following:

- Training in the application or service domain of the project
- Training in the unique tools and methods used by the project or support group
- Training in safety, security, and human factors

3. Document commitments for providing training support to projects and support groups.

SP 1.3

Establish an Organizational Training Tactical Plan

Establish and maintain an organizational training tactical plan.

The organizational training tactical plan is the plan to deliver the training that is the responsibility of the organization and is necessary for individuals to perform their roles effectively. This plan addresses the near-term execution of training and is adjusted periodically in response to changes (e.g., in needs or resources) and to evaluations of effectiveness.

Typical Work Products

1. Organizational training tactical plan

Subpractices

1. Establish the content of the plan.

Organizational training tactical plans typically contain the following:

- Training needs
- Training topics
- Schedules based on training activities and their dependencies
- Methods used for training
- Requirements and quality standards for training materials
- Training tasks, roles, and responsibilities
- Required resources including tools, facilities, environments, staffing, and skills and knowledge

2. Establish commitments to the plan.

Documented commitments by those responsible for implementing and supporting the plan are essential for the plan to be effective.

3. Revise the plan and commitments as necessary.

SP 1.4 Establish a Training Capability

Establish and maintain a training capability to address organizational training needs.

Refer to the Decision Analysis and Resolution process area for more information about how to apply evaluation criteria when selecting training approaches and developing training materials.

Typical Work Products

1. Training materials and supporting artifacts

Subpractices

1. Select appropriate approaches to satisfy organizational training needs.

Many factors may affect the selection of training approaches, including audience-specific knowledge, costs and schedule, and the work environment. Selecting an approach requires consideration of the means to provide skills and knowledge in the most effective way possible given the constraints.

Examples of training approaches include the following:

- Classroom training
- Computer-aided instruction
- Guided self-study
- Formal apprenticeship and mentoring programs
- Facilitated videos
- Chalk talks
- Brown-bag lunch seminars
- Structured on-the-job training

2. Determine whether to develop training materials internally or to acquire them externally.

Determine the costs and benefits of internal training development and of acquiring training externally.

Example criteria that can be used to determine the most effective mode of knowledge or skill acquisition include the following:

- Performance objectives
- Time available to prepare for project execution
- Business objectives
- Availability of in-house expertise
- Availability of training from external sources

Examples of external sources of training include the following:

- Customer-provided training
- Commercially available training courses
- Academic programs
- Professional conferences
- Seminars

3. Develop or obtain training materials.

Training may be provided by the project, support groups, the organization, or an external organization. The organization's training staff coordinates the acquisition and delivery of training regardless of its source.

Examples of training materials include the following:

- Courses
- Computer-aided instruction
- Videos

4. Develop or obtain qualified instructors.

To ensure that internal training instructors have the necessary knowledge and training skills, criteria can be defined to identify, develop, and qualify them. In the case of external training, the organization's training staff can investigate how the training provider determines which instructors will deliver the training. This can also be a factor in selecting or continuing to use a training provider.

5. Describe the training in the organization's training curriculum.

Examples of the information provided in training descriptions for each course include the following:

- Topics covered in the training
- Intended audience
- Prerequisites and preparation for participating
- Training objectives
- Length of the training
- Lesson plans
- Completion criteria for the course
- Criteria for granting training waivers

6. Revise training materials and supporting artifacts as necessary.

Examples of situations in which training materials and supporting artifacts may need to be revised include the following:

- Training needs change (e.g., when new technology associated with the training topic is available)
- An evaluation of the training identifies the need for change (e.g., evaluations of training effectiveness surveys, training program performance assessments, or instructor evaluation forms)

SG 2 Provide Necessary Training

Training necessary for individuals to perform their roles effectively is provided.

When selecting people to be trained, the following should be considered:

- Background of the target population of training participants
- Prerequisite background to receive training
- Skills and abilities needed by people to perform their roles
- Need for cross-discipline technical management training for all disciplines, including project management
- Need for managers to have training in appropriate organizational processes

- Need for training in basic principles of all appropriate disciplines or services to support personnel in quality management, configuration management, and other related support functions
- Need to provide competency development for critical functional areas
- Need to maintain competencies and qualifications of personnel to operate and maintain work environments common to multiple projects

SP 2.1

Deliver Training

Deliver training following the organizational training tactical plan.

Typical Work Products

1. Delivered training course

Subpractices

1. Select those who will receive the training necessary to perform their roles effectively.

The acquirer includes supplier representatives, as appropriate, to ensure selected suppliers can effectively interface with acquirer processes.

Training is intended to impart knowledge and skills to people performing various roles in the organization. Some people already possess the knowledge and skills required to perform well in their designated roles. Training can be waived for these people, but care should be taken that training waivers are not abused.

2. Schedule the training, including any resources, as necessary (e.g., facilities and instructors).

Training should be planned and scheduled. Training is provided that has a direct bearing on work performance expectations. Therefore, optimal training occurs in a timely manner with regard to imminent job-performance expectations.

These performance expectations often include the following:

- Training in the use of specialized tools
- Training in procedures that are new to the person who will perform them

3. Conduct the training.

Experienced instructors should conduct the training. When possible, training is conducted in settings that closely resemble actual performance conditions and includes activities to simulate actual work situations. This approach includes integration of tools, methods, and procedures for competency development. Training is tied to work responsibilities so that on-the-job activities or other outside experiences will reinforce the training within a reasonable time after the training was conducted.

4. Track the delivery of training against the plan.

SP 2.2 Establish Training Records

Establish and maintain records of organizational training.

This practice applies to the training performed at the organizational level. Establishment and maintenance of training records for project- or support-group-sponsored training is the responsibility of each individual project or support group.

Typical Work Products

1. Training records
2. Training updates to the organizational repository

Typical Supplier Deliverables

1. Training records, as appropriate

Subpractices

1. Keep records of all students who successfully complete each training course or other approved training activity as well as those who are unsuccessful.
2. Keep records of all staff members who are waived from training.

The rationale for granting a waiver should be documented, and both the manager responsible and the manager of the excepted individual should approve the waiver.

3. Keep records of all students who successfully complete their required training.
4. Make training records available to the appropriate people for consideration in assignments.

Training records may be part of a skills matrix developed by the training organization to provide a summary of the experience and education of people, as well as training sponsored by the organization.

SP 2.3 Assess Training Effectiveness

Assess the effectiveness of the organization's training program.

A process should exist to determine the effectiveness of training (i.e., how well training is meeting the organization's needs).

Examples of methods used to assess training effectiveness include the following:

- Testing in the training context
- Post-training surveys of training participants
- Surveys of manager satisfaction with post-training effects
- Assessment mechanisms embedded in courseware

Measures may be taken to assess the benefits of training against both the project's and organization's objectives. Particular attention should be paid to the need for various training methods, such as training teams as integral work units. When used, performance objectives should be shared with course participants, unambiguous, observable, and verifiable. The results of the training-effectiveness assessment should be used to revise training materials as described in the Establish a Training Capability specific practice.

Typical Work Products

1. Training-effectiveness surveys
2. Training program performance assessments
3. Instructor evaluation forms
4. Training examinations

Subpractices

1. Assess in-progress or completed projects to determine whether staff knowledge is adequate for performing project tasks.
2. Provide a mechanism for assessing the effectiveness of each training course with respect to established organizational, project, or individual learning (or performance) objectives.
3. Obtain student evaluations of how well training activities met their needs.

PROJECT MONITORING AND CONTROL

A Project Management Process Area at Maturity Level 2

Purpose

The purpose of Project Monitoring and Control (PMC) is to provide an understanding of the project's progress so that appropriate corrective actions can be taken when the project's performance deviates significantly from the plan.

Introductory Notes

A project's documented plan is the basis for monitoring activities, communicating status, and taking corrective action. Progress is primarily determined by comparing actual work product and task attributes, effort, cost, and schedule to the plan at prescribed milestones or control levels in the project schedule or WBS. Appropriate visibility of progress enables timely corrective action to be taken when performance deviates significantly from the plan. A deviation is significant if, when left unresolved, it precludes the project from meeting its objectives.

The term *project plan* is used throughout these practices to refer to the overall plan for controlling the project.

Monitoring and control functions are established early in the project as the project's planning is performed and the acquisition strategy is defined. As the acquisition of technology solutions unfolds, monitoring and control activities are essential to ensure that appropriate resources are being applied and that acquirer activities are progressing according to plan.

When actual status deviates significantly from expected values, corrective actions are taken, as appropriate. These actions may require replanning, which may include revising the original plan, establishing new agreements, or including additional mitigation activities in the current plan.

If corrective action is required to resolve variances from project plans, these actions should be defined and tracked to closure.

After one or more suppliers are selected and agreements are established, the role of monitoring and control becomes twofold: (1) the acquirer continues to monitor and control its activities and work products while also (2) monitoring and controlling the progress and performance of supplier activities that affect the overall project plan.

The supplier project progress and performance reporting requirements are established in the supplier agreement consistent with the needs of the project.

Related Process Areas

Refer to the Project Planning process area for more information about the project plan, including how it specifies the appropriate level of project monitoring, measures used to monitor progress, and known risks.

Refer to the Measurement and Analysis process area for more information about the process of measuring, analyzing, and recording information.

Refer to the Agreement Management process area for more information about resolving supplier agreement issues.

Refer to the Solicitation and Supplier Agreement Development process area for more information about making changes to the supplier agreement.

Specific Goal and Practice Summary

SG 1 Monitor the Project Against the Plan

- SP 1.1 Monitor Project Planning Parameters
- SP 1.2 Monitor Commitments
- SP 1.3 Monitor Project Risks
- SP 1.4 Monitor Data Management
- SP 1.5 Monitor Stakeholder Involvement
- SP 1.6 Conduct Progress Reviews
- SP 1.7 Conduct Milestone Reviews
- SP 1.8 Monitor Transition to Operations and Support

SG 2 Manage Corrective Action to Closure

- SP 2.1 Analyze Issues
- SP 2.2 Take Corrective Action
- SP 2.3 Manage Corrective Actions

Specific Practices by Goal

SG 1 Monitor the Project Against the Plan

Actual performance and progress of the project are monitored against the project plan.

Monitoring acquirer progress and performance begins as soon as a plan is established. The acquirer is responsible for monitoring the progress and output of the project. After a supplier is selected and a supplier agreement put in place, the acquirer's monitoring and control activities extend to the supplier and its activities. The acquirer monitors supplier progress, including achievement of requirements established in the supplier agreement and using specified process, product, and service level measures.

SP 1.1 Monitor Project Planning Parameters

Monitor actual values of project planning parameters against the project plan.

Project planning parameters constitute typical indicators of project progress and performance and include attributes of work products and tasks, costs, effort, and schedule. Attributes of the work products and tasks include size, complexity, weight, form, fit, and function.

Monitoring typically involves measuring actual values of project planning parameters, comparing actual values to estimates in the plan, and identifying significant deviations. Recording actual values of project planning parameters includes recording associated contextual information to help understand measures. An analysis of the impact that significant deviations have on determining the corrective actions to take is handled in specific goal 2 and its specific practices in this process area.

Typical Work Products

1. Records of project performance
2. Records of significant deviations
3. Cost performance reports

Typical Supplier Deliverables

1. Supplier project progress and performance reports
2. Records of significant deviations
3. Cost performance reports

Subpractices

1. Monitor progress against the schedule.

Progress monitoring typically includes the following:

- Periodically measuring the actual completion of activities and milestones
- Comparing actual completion of activities and milestones against the project plan schedule
- Identifying significant deviations from the project plan budget and schedule estimates

2. Monitor the project's costs and expended effort.

An example of a system for monitoring and updating the project's costs and expended effort is an Earned Value Management System (EVMS) [GEIA 748 2002].

Effort and cost monitoring typically includes the following:

- Periodically measuring the actual effort and costs expended and staff assigned
- Comparing actual effort, costs, staffing, and training to the project plan budget and estimates
- Identifying significant deviations from the project plan budget and schedule

3. Monitor the attributes of work products and tasks.

Refer to the Project Planning process area for more information about the attributes of work products and tasks.

Refer to the Measurement and Analysis process area for more information about measures defined to support management information needs.

Monitoring the attributes of work products and tasks typically includes the following:

- Periodically measuring the actual attributes of work products and tasks, such as size or complexity (and changes to these attributes)
- Comparing the actual attributes of work products and tasks (and changes to these attributes) to project plan estimates
- Identifying significant deviations from project plan estimates

Monitoring attributes applies to both acquirer and supplier work products and tasks.

4. Monitor resources provided and used.

Refer to the Project Planning process area for more information about planned resources.

This resource monitoring includes monitoring the availability of resources provided by the supplier for the project.

5. Monitor the knowledge and skills of project personnel.

Refer to the Project Planning process area for more information about planning for the knowledge and skills needed to perform the project.

Monitoring the knowledge and skills of project personnel typically includes the following:

- Periodically measuring the acquisition of knowledge and skills by project personnel
- Comparing actual training obtained to that documented in the project plan
- Identifying significant deviations from estimates in the project plan

Personnel monitoring includes monitoring the skills and knowledge of supplier personnel provided for the project.

6. Document significant deviations in project planning parameters.

Document significant deviations that apply either to acquirer project execution or to supplier deviations from the project plan.

Refer to the Solicitation and Supplier Agreement Development process area for more information about modifying supplier agreements to reflect change requests.

SP 1.2 Monitor Commitments

Monitor commitments against those identified in the project plan.

Resource commitments that result in expenditures (e.g., issued purchase orders and completed supplier deliverables that are accepted) are tracked when the expense is incurred, even prior to formal payment, to ensure that future financial and legal obligations are accounted for as soon as they are incurred. Commitments that do not result in expenditures (e.g., allocation of resources or skill sets) should also be monitored.

Supplier commitments for the project are also monitored by the acquirer through these practices.

Typical Work Products

1. Records of commitment reviews

Subpractices

1. Regularly review commitments (both external and internal).
2. Identify commitments that have not been satisfied or are at significant risk of not being satisfied.
3. Document the results of commitment reviews.

SP 1.3 Monitor Project Risks

Monitor risks against those identified in the project plan.

Refer to the Project Planning process area for more information about identifying project risks.

Refer to the Risk Management process area for more information about risk management activities.

The acquirer monitors the overall project risk. Many risks are the sole responsibility of the acquirer and may include information that should not be shared with the supplier (e.g., source selection sensitive, re-competition, or internal staffing).

There can also be risks that require careful coordination with suppliers and the establishment of appropriate mechanisms for the escalation of risks and risk status (e.g., feasibility of the technology to meet end-user performance requirements). Shared risks may require jointly planned mitigations.

Typical Work Products

1. Records of project risk monitoring

Typical Supplier Deliverables

1. Records of supplier risk monitoring

Subpractices

1. Periodically review the documentation of risks in the context of the project's current status and circumstances.

This review includes the risks defined in the solicitation package, those identified by the supplier in their proposal, and those raised as part of regular supplier status reporting.

2. Revise the documentation of risks as additional information becomes available.
3. Communicate the risk status to relevant stakeholders.

Examples of risk status include the following:

- A change in the probability that the risk occurs
- A change in risk priority

SP 1.4 Monitor Data Management

Monitor the management of project data against the project plan.

Refer to the Plan Data Management specific practice in the Project Planning process area for more information about identifying types of data to be managed and how to plan for their management.

Once plans for the management of project data are made, the management of that data must be monitored to ensure that those plans are accomplished.

Typical Work Products

1. Records of data management

Typical Supplier Deliverables

1. Records of supplier data management

Subpractices

1. Periodically review data management activities against their description in the project plan.
2. Identify and document significant issues and their impacts.
3. Document results of data management activity reviews.

SP 1.5 Monitor Stakeholder Involvement

Monitor stakeholder involvement against the project plan.

Refer to the Plan Stakeholder Involvement specific practice in the Project Planning process area for more information about identifying relevant stakeholders and planning appropriate involvement with them.

Once stakeholders are identified and the extent of their involvement in the project is specified in project planning, that involvement must be monitored to ensure that appropriate interactions are occurring.

This monitoring is particularly true in a system of systems environment in which the involvement of owners, acquirers, and customers of other systems in the system of systems is crucial to the success of that system of systems.

Typical Work Products

1. Records of stakeholder involvement

Typical Supplier Deliverables

1. Records of supplier involvement

Subpractices

1. Periodically review the status of stakeholder involvement.
2. Identify and document significant issues and their impacts.
3. Document the results of stakeholder involvement status reviews.

SP 1.6 Conduct Progress Reviews

Periodically review the project's progress, performance, and issues.

Progress reviews are project reviews to keep stakeholders informed. These project reviews can be informal and may not be specified explicitly in project plans.

Refer to the Agreement Management process area for more information about conducting reviews with the supplier per the supplier agreement.

Refer to the Solicitation and Supplier Agreement Development process area for more information about establishing review requirements in the supplier agreement.

Typical Work Products

1. Documented project review results

Typical Supplier Deliverables

1. Supplier project progress and performance reports
2. Supplier review materials and reports
3. Documentation of product and document deliveries

Subpractices

1. Regularly communicate status on assigned activities and work products to relevant stakeholders.

Managers, staff members, customers, end users, suppliers, and other relevant stakeholders in the organization are included in reviews, as appropriate.

2. Review the results of collecting and analyzing measures for controlling the project.

Examples of classes of commonly used acquirer measures include the following:

- Requirements volatility
- Return on investment
- Cost performance index
- Number of defects per phase and by severity of defects
- Schedule performance index
- Customer satisfaction trends
- Supplier performance and relationship trends

Refer to the Measurement and Analysis process area for more information about measuring and analyzing project performance data.

3. Identify and document significant issues and deviations from the plan.

This activity includes identifying and documenting both acquirer and supplier issues and deviations.

4. Document change requests and problems identified in work products and processes.

Refer to the Configuration Management process area for more information about managing changes.

5. Document the results of reviews.
6. Track change requests and problem reports to closure.

SP 1.7 Conduct Milestone Reviews

Review the project's accomplishments and results at selected project milestones.

Refer to the Project Planning process area for more information about milestone planning.

Refer to the Measurement and Analysis process area for more information about the process of measuring, analyzing, and recording project performance data.

Milestone reviews are planned during project planning and are typically formal reviews.

Typical Work Products

1. Documented milestone review results

Typical Supplier Deliverables

1. Documented measurement results
2. Measurement analysis reports

Subpractices

1. Conduct milestone reviews with relevant stakeholders at meaningful points in the project's schedule, such as the completion of selected stages.

Managers, staff members, customers, end users, suppliers, and other relevant stakeholders in the organization are included in milestone reviews, as appropriate.

Conduct milestone reviews with the supplier as specified in the supplier agreement.

Refer to the Acquisition Technical Management process area for more information about conducting technical reviews with the supplier per the supplier agreement.

Refer to the Solicitation and Supplier Agreement Development process area for more information about establishing review requirements in the supplier agreement.

2. Review commitments, the plan, the status, and risks of the project.
3. Identify and document significant issues and their impacts.
4. Document results of the review, action items, and decisions.
5. Track action items to closure.

SP 1.8 Monitor Transition to Operations and Support

Monitor transition to operations and support.

The acquirer monitors and controls the transition of the accepted product or service against the plan for transition to operations and support.

Refer to the Plan Transition to Operations and Support specific practice in the Project Planning process area for more information about planning for the transition of the product or service to operations and support.

Typically, the supplier has a role in integrating and packaging products and prepares for the transition to operations and support, including support for business user acceptance; the acquirer monitors these supplier activities. These expectations of the supplier and the acceptance criteria for transition to operations and support are included in the solicitation package and then the supplier agreement.

Typical Work Products

1. Transition readiness report
2. Records of transition to support reviews
3. Transition analysis report

Typical Supplier Deliverables

1. Training materials and supporting artifacts
2. Site readiness report
3. Verification reports
4. Training records
5. Operational readiness reports
6. Test results
7. Pilot results

Subpractices

1. Monitor the operations and support organization's capability and facilities designated to receive, store, use, and maintain acquired products.

The acquirer makes adequate provisions through the supplier agreement or in-house operations and support organizations to operate the acquired product. Typically, the acquirer uses verification practices to confirm that the organization, physical environment, and operations and support resources are equipped to execute operations and support activities.

The acquirer also reviews operations and support organizations designated to take responsibility for the operation of the product and to ensure that resources identified and budgeted are available when needed. The designated operations and support organizations demonstrate their readiness (i.e., capability and capacity) to accept responsibility for the product and to ensure uninterrupted support. Typically, a demonstration involves execution of all the activities of operations (e.g., a pilot).

2. Monitor the delivery of training for those involved in receiving, storing, using, and maintaining acquired products.

Typically, the supplier develops training resources for the product. Training materials and resources are specified in the supplier agreement to meet the needs of various audiences (e.g., operations staff, support staff, end users). The acquirer verifies that training is provided at the appropriate time to the appropriate audience and determines whether the training capability provided is adequate.

3. Review pilot results, if any, and operational readiness reports for the acquired product.

Determine readiness of the product and involved stakeholders, such as the operations and support organizations, for the transition of responsibility. The acquirer typically uses transition readiness criteria and verification and validation practices to determine if the supplier-delivered products meet specified requirements. The criteria also address the readiness of the product for maintenance over the intended product lifecycle.

4. **Review and analyze the results of transition activities.**

The acquirer reviews and analyzes the results of transition activities and determines whether corrective actions must be completed before responsibility is transferred to the operational and support organizations.

Example reports and logs used by the acquirer include the following:

- Transition activity reports, including quality measures collected during the pilot and the warranty period
- Problem tracking reports, detailing resolution time, escalation, and root cause analysis
- Change management reports
- Configuration management records
- Operation logs to determine that sufficient information is stored to support reconstruction
- Security reports
- Actual operations and support costs compared to estimates

SG 2 Manage Corrective Action to Closure

Corrective actions are managed to closure when the project's performance or results deviate significantly from the plan.

When the acquirer determines (e.g., through its monitoring of measurement data) that supplier progress does not appear to be sufficient to meet a service level defined in the supplier agreement, then the acquirer initiates and manages corrective action with the supplier.

If the supplier does not comply appropriately with the acquirer's initiation of corrective action, the acquirer escalates and resolves this issue as a supplier agreement issue.

SP 2.1 Analyze Issues

Collect and analyze issues and determine corrective actions necessary to address them.

Corrective action is taken for both acquirer deviations and when supplier execution does not align with project planning (e.g., milestones and work product date slippages).

Many issues and corrective actions are the sole responsibility of the acquirer and may include information that should not be shared with the supplier (e.g., source selection sensitive, re-competition, and internal staffing).

Typical Work Products

1. List of issues needing corrective actions

Typical Supplier Deliverables

1. List of supplier issues needing corrective action by the acquirer

Subpractices

1. Gather issues for analysis.

Issues are collected from reviews and the execution of other processes.

Examples of issues to be gathered include the following:

- Issues discovered when performing technical reviews, verification, and validation activities
- Significant deviations in project planning parameters from estimates in the project plan
- Commitments (either internal or external) that have not been satisfied
- Significant changes in risk status
- Data access, collection, privacy, or security issues
- Stakeholder representation or involvement issues

2. Analyze issues to determine the need for corrective action.

Refer to the Project Planning process area for more information about corrective action criteria.

Corrective action is required when the issue, if left unresolved, may prevent the project from meeting its objectives.

SP 2.2 Take Corrective Action

Take corrective action on identified issues.

Some corrective actions may be assigned to a supplier. The acquirer oversees corrective actions assigned to the supplier, as appropriate.

Typical Work Products

1. Corrective action plans

Typical Supplier Deliverables

1. Corrective action plans for supplier issues

Subpractices

1. Determine and document the appropriate actions needed to address identified issues.

Refer to the Project Planning process area for more information about the project plan when replanning is needed.

Examples of potential actions include the following:

- Modifying the statement of work
- Modifying requirements
- Revising estimates and plans
- Renegotiating commitments
- Adding resources
- Changing processes
- Revising project risks

2. Review and get agreement with relevant stakeholders on the actions to be taken.
3. Negotiate changes to internal and external commitments.

SP 2.3 Manage Corrective Actions

Manage corrective actions to closure.

Typical Work Products

1. Corrective action results

Typical Supplier Deliverables

1. Corrective action results for supplier issues

Subpractices

1. Monitor corrective actions for their completion.
2. Analyze results of corrective actions to determine the effectiveness of the corrective actions.
3. Determine and document appropriate actions to correct deviations from planned results for corrective actions.

Lessons learned as a result of taking corrective action can be inputs to planning and risk management processes.

PROJECT PLANNING

A Project Management Process Area at Maturity Level 2

Purpose

The purpose of Project Planning (PP) is to establish and maintain plans that define project activities.

Introductory Notes

The Project Planning process area involves the following activities:

- Developing the project plan
- Interacting with stakeholders appropriately
- Getting commitment to the plan
- Maintaining the plan

Planning begins with requirements that define the product and project.

Project planning is based on the acquisition strategy, which is a guide for directing and controlling the project and a framework for integrating activities essential to acquiring an operational product or service. The acquisition strategy outlines acquisition objectives and constraints, availability of assets and technologies, consideration of acquisition methods, potential supplier agreement types and terms, accommodation of end-user considerations, considerations of risk, and support for the project throughout the project lifecycle.

Planning includes estimating the attributes of work products and tasks, determining the resources needed, negotiating commitments, producing a schedule, and identifying and analyzing project risks. Iterating through these activities may be necessary to establish the project plan. The project plan provides the basis for performing and controlling project activities that address commitments with the project's customer.

Project Planning involves the development and maintenance of plans for all acquirer processes, including those required for effective acquirer-supplier interaction. Once the supplier agreement is signed and schedule, costs, and resources from the supplier are established, the acquirer takes the supplier estimations for the project into account at an appropriate level of detail in its project plan.

Project planning includes establishing and maintaining a plan for the orderly, smooth transition of the acquired product from a supplier to its use by the acquirer or its customers. In addition, if an existing product is to be replaced as part of the acquisition, the acquirer may be required to consider the disposal of the existing product as part of the planning for acquiring the new product. All transition activities are included in the project plan and provisions for accommodating such specialized requirements are also included.

All relevant stakeholders should be involved in the planning process from all lifecycle phases to ensure all technical and support activities are adequately addressed in project plans.

The project plan is usually revised as the project progresses to address changes in requirements and commitments, inaccurate estimates, corrective actions, and process changes. Specific practices describing both planning and replanning are contained in this process area.

Changes to the supplier agreement can also affect the project's planning estimates, budget, schedules, risks, project work tasks, commitments, and resources.

The term *project plan* is used throughout the generic and specific practices in this process area to refer to the overall plan for controlling the project.

Related Process Areas

Refer to the Acquisition Requirements Development process area for more information about developing requirements.

Refer to the Requirements Management process area for more information about managing requirements needed for planning and replanning.

Refer to the Risk Management process area for more information about identifying and managing risks.

Refer to the Acquisition Technical Management process area for more information about evaluations and reviews that must be included in technical planning.

Refer to the Solicitation and Supplier Agreement Development process area for more information about establishing and maintaining supplier agreements.

Refer to the Measurement and Analysis process area for more information about specifying measures.

Specific Goal and Practice Summary

SG 1 Establish Estimates

- SP 1.1 Establish the Acquisition Strategy
- SP 1.2 Estimate the Scope of the Project
- SP 1.3 Establish Estimates of Work Product and Task Attributes
- SP 1.4 Define Project Lifecycle Phases
- SP 1.5 Estimate Effort and Cost

SG 2 Develop a Project Plan

- SP 2.1 Establish the Budget and Schedule
- SP 2.2 Identify Project Risks
- SP 2.3 Plan Data Management
- SP 2.4 Plan the Project's Resources
- SP 2.5 Plan Needed Knowledge and Skills
- SP 2.6 Plan Stakeholder Involvement
- SP 2.7 Plan Transition to Operations and Support
- SP 2.8 Establish the Project Plan

SG 3 Obtain Commitment to the Plan

- SP 3.1 Review Plans That Affect the Project
- SP 3.2 Reconcile Work and Resource Levels
- SP 3.3 Obtain Plan Commitment

Specific Practices by Goal

SG 1 Establish Estimates

Estimates of project planning parameters are established and maintained.

Project planning parameters include all information needed by the project to perform necessary planning, organizing, staffing, directing, coordinating, reporting, and budgeting.

The acquirer develops estimates for project work based on the acquisition strategy, including high-level estimates for the work to be done by suppliers. Initial estimates may be revised based on supplier estimates in response to the solicitation package.

Estimates of planning parameters should have a sound basis to instill confidence that plans based on these estimates are capable of supporting project objectives.

Factors that are typically considered when estimating these parameters include the following:

- The acquisition strategy
- Project requirements, including product requirements, requirements imposed by the organization, requirements imposed by the customer, and other requirements that impact the project
- The scope of the project
- Identified tasks and work products
- The technical approach
- The selected project lifecycle model (e.g., waterfall, incremental, or spiral)
- Attributes of work products and tasks (e.g., size or complexity)
- The schedule
- Models or historical data used for converting attributes of work products and tasks into labor hours and costs
- The methodology (e.g., models, data, algorithms) used to determine needed material, skills, labor hours, and cost

The acquisition strategy is a key factor when estimating the project.

Documentation of the estimating rationale and supporting data is needed for stakeholder review and commitment to the plan and for maintenance of the plan as the project progresses.

SP 1.1 Establish the Acquisition Strategy

Establish and maintain the acquisition strategy.

The acquisition strategy is the business and technical management framework for planning, executing, and managing agreements for a project. The acquisition strategy relates to the objectives for the acquisition, the constraints, availability of resources and technologies, consideration of acquisition methods, potential supplier agreement types, terms and conditions, accommodation of business considerations, considerations of risk, and support for the acquired product over its lifecycle. The acquisition strategy reflects the entire scope of the project. It encompasses the work to be performed by the acquirer and the supplier, or in some cases multiple suppliers, for the full lifecycle of the product.

The acquisition strategy results from a thorough understanding of both the acquisition project and the general acquisition environment. The acquirer accounts for the potential value or benefit of the acquisition in the light of potential risks, considers constraints, and takes into account experiences with different types of suppliers, agreements, and terms. A well-developed strategy minimizes the time and cost required to satisfy approved capability needs, and maximizes affordability throughout the project lifecycle.

The acquisition strategy is the basis for formulating solicitation packages, supplier agreements, and project plans. The strategy evolves over time and should continuously reflect the current status and desired end point of the project.

Typical Work Products

1. Acquisition strategy

Subpractices

1. Identify the capabilities and objectives the acquisition is intended to satisfy or provide.

The capabilities describe what the organization intends to acquire. Typically, the capabilities included in the acquisition strategy summary highlight product characteristics driven by interoperability or families of products. The acquisition strategy also identifies dependencies on planned or existing capabilities of other projects or products.

Refer to the Acquisition Requirements Development process area for more information about determining capabilities and customer requirements.

The acquirer defines objectives in terms of cost, schedule, and key process, product, and service level measures and technical performance measures as defined in requirements. These measures reflect customer expectations and threshold values representing acceptable limits that, in the customer's judgment, provide the needed capability. While the number and specificity of measures may change over the duration of an acquisition, the acquirer typically focuses on the minimum number of measures that, if thresholds are not met, will require a re-evaluation of the project.

The acquisition strategy establishes the milestone decision points and acquisition phases planned for the project. It prescribes the accomplishments for each phase and identifies the critical events affecting project management. Schedule parameters include, at a minimum, the projected dates for project initiation, other major decision points, and initial operational capability.

Examples of cost parameters include the following:

- Research, development, test, and evaluation costs
- Acquisition costs
- Acquisition-related operations, support, and disposal costs
- Total product quantity (to include both fully configured development and production units)

2. Identify the acquisition approach.

The acquirer defines the approach the project will use to achieve full capability—either evolutionary or single step—and includes a brief rationale to justify the choice. When a project uses an evolutionary acquisition approach, the acquisition strategy describes the initial capability and how it will be funded, developed, tested, produced, and supported. The acquisition strategy previews similar planning for subsequent increments and identifies the approach to integrate or retrofit earlier increments with later increments.

Examples of additional considerations for the acquisition approach include the following:

- Actions a project team can take on its own if the acquiring organization has an acquisition, contracting, or purchasing department
- Who will prepare independent estimates and if these estimates are needed as evaluation criteria
- Managing multiple suppliers
- Anticipated lead times from potential suppliers to acquire items

3. Document business considerations.

Business considerations include the type of competition planned for all phases of the acquisition or an explanation of why competition is not practicable or not in the best interests of the acquirer. Also included are considerations for establishing or maintaining access to competitive suppliers for critical products or product components.

Availability and suitability of commercial items and the extent to which interfaces for these items have broad market acceptance, standards, organization support, and stability are other business considerations. Also included are considerations for both international and domestic sources that can meet the required need as primary sources of supply consistent with organizational policies and regulations.

Other examples of business considerations for an acquisition strategy include the following:

- Product and technology areas critical to satisfying or providing the desired capabilities
- Data rights
- Socio-economic constraints
- Safety and health issues
- Security issues (physical and information technology)

4. Identify major risks and which risks will be addressed jointly with the supplier.

Major acquisition risks, whether primarily managed by the acquirer or supplier, should be identified and assessed by the acquirer. The acquisition strategy identifies major risks, which risks are to be shared with the supplier, and which are retained by the acquirer.

Refer to the Risk Management process area for more information about establishing and maintaining a risk management strategy.

5. Identify the preferred supplier agreement type.

The acquirer identifies standardized acquisition documents (e.g., standard supplier agreements), if any. The acquirer also determines the preferred type of supplier agreement (e.g., firm fixed-price; fixed-price incentive, firm target; cost plus incentive fee; or cost plus award fee) and the reasons it is suitable, including considerations of risk and reasonable risk-sharing by the acquirer and supplier.

The acquisition strategy explains the planned incentive structure for the acquisition and how it encourages the supplier to provide the product or service at or below the established cost objectives and satisfy the schedule and key measurement objectives. Considerations should be given to using incentives to reduce primary project risks. If more than one incentive is planned for a supplier agreement, the acquisition strategy explains how the incentives complement one other and do not interfere with one another. The acquisition strategy identifies unusual terms and conditions of the planned supplier agreement and all existing or contemplated deviations to an organization's terms and conditions, if any.

6. Identify the product support strategy.

The acquirer develops a product support strategy for lifecycle sustainment and continuous improvement of product affordability, reliability, and supportability, while sustaining readiness. The support strategy addresses how the acquirer will maintain oversight of the fielded product.

If support is going to be performed by an organization different from the supplier, a sufficient overlap period should be defined to ensure smooth transition.

The acquirer's sustainment organization or supplier typically participates in the development of the product support strategy.

7. **Review and obtain agreement with senior management on the acquisition strategy.**

The development of the acquisition strategy for a project typically requires senior management sponsorship. Appropriate senior management must approve the acquisition strategy before initiating a project.

SP 1.2 Estimate the Scope of the Project

Establish a top-level work breakdown structure (WBS) to estimate the scope of the project.

The acquirer establishes the objectives of the project in the acquisition strategy. An initial set of requirements and project objectives form the basis for establishing the WBS or for selecting a standard WBS from the organization's process assets. To ensure the full scope of the project is estimated, the WBS includes activities performed by the acquirer as well as milestones and deliverables for suppliers.

The acquisition strategy drives a key decision in this practice, specifically how much work, and what work, to give to a supplier. The acquirer develops a WBS that clearly identifies the project work performed by the acquirer and the project work performed by the supplier. The supplier work identified in the WBS becomes the foundation for the statement of work defined in the *Solicitation and Supplier Agreement Development* process area. The WBS identifies deliverables from the supplier and work products developed by the acquirer.

The WBS evolves with the project. Initially a top-level WBS can serve to structure initial estimating. The development of a WBS divides the overall project into an interconnected set of manageable components. Typically, the WBS is a product-oriented structure that provides a scheme for identifying and organizing the logical units of work to be managed, which are called *work packages*. The WBS provides a reference and organizational mechanism for assigning effort, schedule, and responsibility and is used as the underlying framework to plan, organize, and control the work done on the project. Some projects use the term *contract WBS* to refer to the portion of the WBS placed under contract (possibly the entire WBS). Not all projects have a contract WBS (e.g., internally funded development).

Typical Work Products

1. Task descriptions
2. Work package descriptions
3. WBS

Subpractices

1. Develop a WBS based on the product architecture.

The WBS should permit the identification of the following items:

- Risks and their mitigation tasks
- Tasks for deliverables and supporting activities
- Tasks for skill and knowledge acquisition
- Tasks for the development of needed support plans, such as configuration management, quality assurance, and verification plans
- Tasks for the integration and management of nondevelopmental items

2. Identify the work packages in sufficient detail to specify estimates of project tasks, responsibilities, and schedule.

The top-level WBS is intended to help gauge the project work effort for tasks and organizational roles and responsibilities. The amount of detail in the WBS at this level helps in developing realistic schedules, thereby minimizing the need for management reserve.

3. Identify products and product components to be externally acquired.
4. Identify work products to be reused.

SP 1.3 Establish Estimates of Work Product and Task Attributes

Establish and maintain estimates of work product and task attributes.

Size is the primary input to many models used to estimate effort, cost, and schedule. The models can also be based on inputs such as connectivity, complexity, and structure.

Examples of types of work products for which size estimates are made include the following:

- Deliverable and nondeliverable work products
- Documents and files
- Operational and support hardware, firmware, and software

Estimation methods include using historical acquirer and supplier data and standard estimating models to compare projects of similar complexity. Where historical size data are not available, develop an estimate based on the understanding of the design of similar products.

Estimation models can be built based on historical data as part of organizational process performance, and estimates for any project can be validated using these models.

Refer to the Organizational Process Performance process area for more information about process-performance models.

Examples of size measures include the following:

- Number of functions
- Function points
- Source lines of code
- Number of classes and objects
- Number of requirements
- Number and complexity of interfaces
- Number of pages
- Number of inputs and outputs
- Number of technical risk items
- Volume of data
- Number of logic gates for integrated circuits
- Number of parts (e.g., printed circuit boards, components, and mechanical parts)
- Physical constraints (e.g., weight and volume)

The estimates should be consistent with project requirements to determine the project's effort, cost, and schedule. A relative level of difficulty or complexity should be assigned for each size attribute.

Typical Work Products

1. Technical approach
2. Size and complexity of tasks and work products
3. Estimating models
4. Attribute estimates

Subpractices

1. Determine the technical approach for the project.

The technical approach defines a top-level strategy for development of the product. It includes decisions on architectural features, such as distributed or client/server; state-of-the-art or established technologies to be applied, such as robotics, composite materials, or artificial intelligence; and breadth of the functionality expected in the final products, such as safety, security, and ergonomics.

The technical approach provides a basis for interoperability and supportability of the technical solution developed by the supplier.

2. Use appropriate methods to determine the attributes of the work products and tasks to be used to estimate resource requirements.

Methods for determining size and complexity should be based on validated models or historical data.

Examples of attributes include the following:

- Maturity of the technology specified in the technical solution
- Amount and complexity of the work potentially assigned to suppliers
- Number of locations where the product is to be installed

The methods for determining attributes evolve as the understanding of the relationship of product characteristics to attributes increases.

Examples of current methods include the following:

- Number of logic gates for integrated circuit design
- Lines of code or function points for software
- Number and complexity of requirements for systems engineering
- Number of square feet for standard-specified residential homes

3. Estimate the attributes of work products and tasks.

SP 1.4 Define Project Lifecycle Phases

Define project lifecycle phases on which to scope the planning effort.

The determination of a project's lifecycle phases provides for planned periods of evaluation and decision making. These periods are normally defined to support logical decision points at which significant commitments are made concerning resources and technical approach. Such points provide planned events at which project course corrections and determinations of future scope and cost can be made.

Project lifecycle phases must be defined depending on the scope of requirements, estimates for project resources, and the nature of the project.

The acquirer includes the entire project lifecycle (i.e., from user needs through initial and subsequent upgrades) when planning lifecycle phases and refines the acquisition strategy as appropriate. The acquirer considers all supplier agreements in the context of the acquisition so that an integrated approach results. A complex project can involve managing multiple supplier agreements simultaneously or in sequence. In such cases, any acquisition lifecycle can end during any phase of the project lifecycle. Depending on the acquisition strategy, there may be intermediate phases for the creation of prototypes, increments of capability, or spiral model cycles.

Refer to the Establish Lifecycle Model Descriptions specific practice in the Organizational Process Definition process area for more information about acquisition lifecycles.

During establishment of the supplier agreement, the acquirer works with the supplier to understand supplier lifecycle models and processes, especially those that interact directly with acquirer processes.

Agreement on the lifecycle models and processes to be used during the project enables seamless interactions between supplier and acquirer, resulting in a successful acquirer-supplier relationship.

Understanding the project lifecycle is crucial in determining the scope of the planning effort and the timing of initial planning, as well as the timing and criteria (critical milestones) for replanning.

Typical Work Products

1. Project lifecycle phases

SP 1.5 Estimate Effort and Cost

Estimate the project's effort and cost for work products and tasks.

Estimates of effort and cost are generally based on results of analysis using models or historical data applied to size, activities, and other planning parameters. Confidence in these estimates is based on rationale for the selected model and the nature of the data. There may be occasions when available historical data does not apply, such as when efforts are unprecedented or when the type of task does not fit available models. An effort is unprecedented (to some degree) if a similar product or component has never been built. An effort may also be unprecedented if the development group has never built such a product or component.

Unprecedented efforts are more risky, require more research to develop reasonable bases of estimate, and require more management reserve. The uniqueness of the project must be documented when using these models to ensure a common understanding of assumptions made in the initial planning stages.

Estimates address all processes and activities performed by the project for the project lifecycle, including an estimate of effort and cost for supplier work. The project estimate includes detailed estimates for activities performed by the acquirer and its stakeholders. The acquirer should include members of their technical community (e.g., systems, hardware, and software engineers) to ensure all technical considerations have been accounted for in the estimates. As the project evolves, these estimates may be revised based on changed conditions (e.g., new circumstances encountered during execution of the supplier agreement).

In addition to creating an estimate for the project work products, the acquirer is encouraged to have its estimate and WBS independently reviewed by individuals external to the project to ensure that the project estimation and WBS can be validated.

Typical Work Products

1. Estimation rationale
2. Project effort estimates
3. Project cost estimates

Subpractices

1. Collect models or historical data to be used to transform the attributes of work products and tasks into estimates of labor hours and costs.

Effort estimation at the work product and task level needs to be established for acquirer work. Effort estimation for supplier deliverables and processes must be established as well.

Many parametric models have been developed to help estimate cost and schedule. The use of these models as the sole source of estimation is not recommended because these models are based on historical project data that may or may not be pertinent to your project. Multiple models and methods can be used to ensure a high level of confidence in the estimate.

Historical data include the cost, effort, and schedule data from previously executed projects and appropriate scaling data to account for differing sizes and complexity.

2. Include supporting infrastructure needs when estimating effort and cost.

Examples of supporting infrastructure typically provided by the supplier include the following:

- Critical computing resources in the host and testing environment (e.g., memory, disk, and network capability)
- Test equipment

3. Estimate effort and cost using models and historical data.

Effort and cost inputs used for estimating typically include the following:

- Judgmental estimates provided by an expert or group of experts (e.g., Delphi Method)
- Estimates for the development of requirements
- Risks, including the extent to which the effort is unprecedented
- Critical competencies and roles needed to perform the work
- The WBS
- Costs of acquired work products
- Selected project lifecycle model and processes
- Lifecycle cost estimates
- Skill levels of managers and staff needed to perform the work
- Knowledge, skill, and training needs
- Facilities needed (e.g., office and meeting space and workstations)
- Travel required
- Level of security required for tasks, work products, hardware, software, personnel, and the work environment
- Service level agreements for call centers and warranty work
- Direct labor and overhead

The amount of supplier work for a project largely determines the amount of acquirer work required to manage the project and the supplier. Effort for the acquirer includes (1) effort associated with defining the scope of the project; (2) effort associated with the development of the solicitation and supplier agreement; agreement and technical management; project planning, monitoring, and control; acquisition requirements development, verification, and validation; configuration management; measurement and analysis; process and product quality assurance; requirements management; and risk management; (3) operating and maintenance effort associated with the sustainment of the solution; and (4) disposal effort.

SG 2 Develop a Project Plan

A project plan is established and maintained as the basis for managing the project.

A project plan is a formal, approved document used to manage and control the execution of the project. It is based on project requirements and established estimates.

The project plan should consider all phases of the project lifecycle. Project planning should ensure that all plans affecting the project are consistent with the overall project plan.

SP 2.1 Establish the Budget and Schedule

Establish and maintain the project's budget and schedule.

The project's budget and schedule are based on developed estimates and ensure that budget allocation, task complexity, and task dependencies are appropriately addressed.

The project's budget and schedule (including the lifecycle-related activities of the acquirer) the supplier's efforts and those of supporting organizations and other stakeholders (including any supplier that supports the acquirer) are established, tracked, and maintained for the duration of the project. In addition to creating a schedule for project work products, the acquirer should have the schedule independently reviewed by individuals external to the project to ensure that the project schedule can be validated.

Event-driven, resource-limited schedules have proven to be effective in dealing with project risk. Identifying accomplishments to be demonstrated before initiation of an event provides some flexibility in the timing of the event, a common understanding of what is expected, a better vision of the state of the project, and a more accurate status of the project's tasks.

Typical Work Products

1. Project schedules
2. Schedule dependencies
3. Project budget

Subpractices

1. Identify major milestones.

Milestones are often imposed to ensure completion of certain deliverables by the milestone. Milestones can be event based or calendar based. If calendar based, once milestone dates have been agreed on, it is often difficult to change them.

2. Identify schedule assumptions.

When schedules are initially developed, it is common to make assumptions about the duration of certain activities. These assumptions are frequently made on items for which little if any estimation data is available. Identifying these assumptions provides insight into the level of confidence (i.e., uncertainties) in the overall schedule.

3. Identify constraints.

Factors that limit the flexibility of management options must be identified as early as possible. The examination of the attributes of work products and tasks often bring these issues to the surface. Such attributes can include task duration, resources, inputs, and outputs.

Since key characteristics of pre-qualified or other potential suppliers are elements of project success, the acquirer considers these characteristics (e.g., technical and financial capability, management and delivery processes, production capacity, and business type and size) in identifying constraints for the project.

4. Identify task dependencies.

Typically, the tasks for a project can be accomplished in some ordered sequence that minimizes the duration of the project. This sequencing involves the identification of predecessor and successor tasks to determine optimal ordering.

Examples of tools that can help determine optimal ordering of task activities include the following:

- Critical Path Method (CPM)
- Program Evaluation and Review Technique (PERT)
- Resource-limited scheduling
- Critical chain method

5. Define the budget and schedule.

An example of a system used for documenting the costs and schedule of a project is an EVMS [GEIA 748 2002].

Establishing and maintaining the project's budget and schedule typically includes the following:

- Defining the committed or expected availability of resources and facilities
- Determining the time phasing of activities
- Determining a breakout of subordinate schedules
- Defining dependencies among activities (predecessor or successor relationships)
- Defining schedule activities and milestones to support accuracy in progress measurement
- Identifying milestones for the delivery of products to the customer
- Defining activities of appropriate duration
- Defining milestones of appropriate time separation
- Defining a management reserve based on the confidence level in meeting the schedule and budget
- Using appropriate historical data to verify the schedule
- Defining incremental funding requirements
- Documenting project assumptions and rationale
- Determining the approach to incorporating supplier schedules at an appropriate level of detail

6. Establish corrective action criteria.

Criteria are established for determining what constitutes a significant deviation from the project plan. A basis for gauging issues and problems is necessary to determine when corrective action should be taken. Corrective actions may require replanning, which may include revising the original plan, establishing new agreements, or including mitigation activities in the current plan.

Criteria for corrective action are based on key objectives defined in the acquisition strategy using process, product, and service level measures. The measures represent key stakeholder needs and threshold values of acceptable limits that, in the stakeholder's judgment, will provide the needed capability. All measures that represent key stakeholder needs and other measures for monitoring the supplier are defined in the Statement of Work (SOW), along with their associated minimum allowed performance levels. These measures are used to identify issues and problems and gauge whether corrective actions should be taken. The plan should define how these measures will be assessed and evaluated.

SP 2.2 Identify Project Risks

Identify and analyze project risks.

Refer to the Risk Management process area for more information about risk management activities.

Refer to the Monitor Project Risks specific practice in the Project Monitoring and Control process area for more information about risk monitoring activities.

Risks are identified or discovered and analyzed to support project planning. This specific practice should be extended to all plans that affect the project to ensure that appropriate interfacing is taking place among all relevant stakeholders on identified risks.

Project planning risk identification and analysis typically include the following:

- Identifying risks
- Analyzing risks to determine the impact, probability of occurrence, and time frame in which problems are likely to occur
- Prioritizing risks

Risks are identified from multiple perspectives (e.g., acquisition, technical, management, operational, supplier agreement, industry, support, and end user) to ensure all project risks are considered comprehensively in planning activities. Applicable regulatory and statutory requirements with respect to safety and security must be considered while identifying risks.

The acquisition strategy and the risks identified in other project planning activities form the basis for some of the criteria used in evaluation practices in the Solicitation and Supplier Agreement Development process area. As the project evolves, risks may be revised based on changed conditions.

Typical Work Products

1. Identified risks
2. Risk impacts and probability of occurrence
3. Risk priorities

Subpractices

1. Identify risks.

The identification of risks involves the identification of potential issues, hazards, threats, vulnerabilities, and so on that could negatively affect work efforts and plans. Risks must be identified and described in an understandable way before they can be analyzed. When identifying risks, it is a good idea to use a standard method for defining risks. Risk identification and analysis tools can be used to help identify possible problems.

Examples of risk identification and analysis tools include the following:

- Risk taxonomies
- Risk assessments
- Checklists
- Structured interviews
- Brainstorming
- Performance models
- Cost models
- Network analysis
- Quality factor analysis

Numerous risks are associated with acquiring products through suppliers (e.g., the stability of the supplier, the ability to maintain sufficient insight into the progress of their work, the supplier's capability to meet product requirements, and the skills and availability of supplier resources to meet commitments).

The process, product, and service level measures and associated thresholds should be analyzed to identify instances where thresholds are at risk of not being met. These project measures are key indicators of project risk.

2. Document risks.
3. Review and obtain agreement with relevant stakeholders on the completeness and correctness of documented risks.
4. Revise risks, as appropriate.

Examples of when identified risks may need to be revised include the following:

- When new risks are identified
- When risks become problems
- When risks are retired
- When project circumstances change significantly

SP 2.3 Plan Data Management

Plan for the management of project data.

Data are forms of documentation required to support a project in all of its areas (e.g., administration, engineering, configuration management, finance, logistics, quality, safety, manufacturing, and procurement). The data can take any form (e.g., reports, manuals, notebooks, charts, drawings, specifications, files, or correspondence). The data may exist in any medium (e.g., printed or drawn on various materials, photographs, electronic, or multimedia).

Data may be deliverable (e.g., items identified by a project's contract data requirements) or data may be nondeliverable (e.g., informal data, trade studies and analyses, internal meeting minutes, internal design review documentation, lessons learned, and action items). Distribution can take many forms, including electronic transmission.

Data requirements for the project should be established for both data items to be created and their content and form, based on a common or standard set of data requirements. Uniform content and format requirements for data items facilitate understanding of data content and help with consistent management of data resources.

The reason for collecting each document should be clear. This task includes the analysis and verification of project deliverables and nondeliverables, data requirements, and customer-supplied data. Often, data are collected with no clear understanding of how they will be used. Data are costly and should be collected only when needed.

Project data include both acquirer and supplier created data. The acquirer identifies the minimal data required to cost-effectively operate, maintain, and improve the acquired product and to foster source-of-support competition throughout the product's lifecycle in the acquirer's intended environment. Data should be available in a format that is compatible with the intended user's environment and a quality assurance program should be implemented to guarantee the accuracy and completeness of data.

The acquirer considers how data will be shared between acquirer and supplier as well as across relevant stakeholders. In many cases, leaving acquirer data in the physical possession of the supplier and having access to supplier data is the preferred solution. In addition to data access, the requirement for acquirer use, reproduction, manipulation, alteration, or transfer of possession of data should be part of the data management plan. The supplier agreement specifies appropriate acquirer rights to the data acquired, in addition to requirements for delivery or access.

Data, when delivered to the acquirer, are formatted according to accepted data standards to ensure its usability by the acquirer. Planning for managing data, including during transition to operations and support, is addressed as part of project planning to avoid unexpected costs to procure, reformat, and deliver data. Plans for managing data within project teams and the infrastructure required to manage data between the supplier, operational users, and other relevant stakeholders are included.

Project data and plans requiring version control or more stringent levels of configuration control are determined and mechanisms established to ensure project data are controlled. The implications of controlling access to classified and sensitive data (e.g., proprietary, export controlled, source selection sensitive) and other access-controlled data also must be considered.

Typical Work Products

1. Data management plan
2. Master list of managed data
3. Data content and format description
4. Lists of data requirements for acquirers and suppliers
5. Privacy requirements
6. Security requirements
7. Security procedures
8. Mechanisms for data retrieval, reproduction, and distribution
9. Schedule for the collection of project data
10. List of project data to be collected

Subpractices

1. Establish requirements and procedures to ensure privacy and the security of data.

Not everyone will have the need or clearance necessary to access project data. Procedures must be established to identify who has access to which data as well as when they have access to which data.

Security and access control are critical when the acquirer provides data access to the supplier. Security and access control includes access lists of authorized supplier personnel and non-disclosure agreements between the acquirer and supplier.

For example, when the supplier performs work for the acquirer off-site (e.g., off-shore development center), the acquirer must consider additional security measures such as a firewall between acquirer and supplier networks and restricted access to the acquirer's work place.

2. Establish a mechanism to archive data and to access archived data.

Accessed information should be in an understandable form (e.g., electronic or computer output from a database) or represented as originally generated.

The data management plan is ideally supported by an integrated data system that meets the needs of both initial acquisition and support communities. Integrating acquisition and sustainment data systems into a total lifecycle integrated data environment provides the capability needed to plan effectively for sustainment and to facilitate technology insertion for affordability improvements during re-procurement and post-production support, while ensuring that acquisition planners have accurate information about total lifecycle costs.

3. Determine the project data to be identified, collected, and distributed.
4. Decide which project data and plans require version control or more stringent levels of configuration control and establish mechanisms to ensure project data are controlled.

SP 2.4 Plan the Project's Resources

Plan for necessary resources to perform the project.

Defining project resources (e.g., labor, machinery/equipment, materials, and methods) and quantities needed to perform project activities, builds on the initial estimates and provides additional information that can be applied to expand the WBS used to manage the project.

The top-level WBS developed earlier as an estimation mechanism is typically expanded by decomposing these top levels into work packages that represent single work units that can be separately assigned, performed, and tracked. This subdivision is done to distribute management responsibility and provide better management control.

Each work package or work product in the WBS should be assigned a unique identifier (e.g., number) to permit tracking. A WBS can be based on requirements, activities, work products, or a combination of these items. A dictionary that describes the work for each work package in the WBS should accompany the work breakdown structure.

The resource plan must include planning for staff with appropriate training and experience to evaluate supplier proposals and participate in negotiations with suppliers. The resource plan identifies the project resources expected from the supplier, including critical facilities or equipment needed to support the work. The resource plan may be revised based on the supplier agreement or changes in conditions during project execution.

Typical Work Products

1. WBS work packages
2. WBS task dictionary
3. Staffing requirements based on project size and scope

4. Critical facilities and equipment list
5. Process and workflow definitions and diagrams
6. Project administration requirements list

Subpractices

1. Determine process requirements.

The processes used to manage a project must be identified, defined, and coordinated with all relevant stakeholders to ensure efficient operations during project execution.

The acquirer must determine how its processes interact with supplier processes to enable seamless execution of the project and successful acquirer-supplier relationships. Considerations include the use of a common process across multiple suppliers and the acquirer or the use of unique but compatible processes. At the very least, processes should be compatible across interfaces.

2. Determine staffing requirements.

The staffing of a project depends on the decomposition of project requirements into tasks, roles, and responsibilities for accomplishing project requirements as laid out in the work packages of the WBS.

Staffing requirements must consider the knowledge and skills required for each identified position, as defined in the Plan Needed Knowledge and Skills specific practice.

The acquirer determines its staffing requirements, including staffing for solicitation and supplier agreement management activities and staffing expected by the supplier to complete its portion of the work as defined in the WBS.

3. Determine facility, equipment, and component requirements.

Most projects are unique in some sense and require a set of unique assets to accomplish project objectives. The determination and acquisition of these assets in a timely manner are crucial to project success.

Lead-time items must be identified early to determine how they will be addressed. Even when required assets are not unique, compiling a list of all of facilities, equipment, and parts (e.g., number of computers for the personnel working on the project, software applications, and office space) provides insight into aspects of the scope of an effort that are often overlooked.

The acquirer considers what it may need to provide for acceptance of supplier deliverables and for transition and support of the acquired product.

The acquirer must also identify and ensure that facilities or equipment to be provided to the supplier for project work are accounted for in the project plan.

SP 2.5

Plan Needed Knowledge and Skills

Plan for knowledge and skills needed to perform the project.

Refer to the Organizational Training process area for more information about knowledge and skills information to be incorporated into the project plan.

Knowledge delivery to projects involves both training project personnel and acquiring knowledge from outside sources.

Staffing requirements are dependent on the knowledge and skills available to support the execution of the project.

The acquirer plans for knowledge and skills required by the project team to perform their tasks. Knowledge and skill requirements can be derived from project risk.

For example, if the acquirer is purchasing a software-intensive product, it ensures that acquisition personnel assigned to the project have expertise in systems and software engineering or provides training for the project team in these areas.

Orientation and training in acquirer processes and the domain knowledge required to execute the project are also required. The acquirer also plans for knowledge and skills needed from the supplier.

For example, the acquirer can provide role descriptions and skill profiles to the supplier as part of the solicitation package.

Planning for needed knowledge and skills includes ensuring that appropriate training is planned for personnel involved in receiving, storing, using, and supporting the transitioned product. Also included is ensuring that costs and funding sources to pay for training are available and lead times to obtain the funding are identified.

Typical Work Products

1. Inventory of skill needs
2. Staffing and new hire plans
3. Databases (e.g., skills and training)
4. Training plans

Subpractices

1. Identify the knowledge and skills needed to perform the project.
2. Assess the knowledge and skills available.
3. Select mechanisms for providing needed knowledge and skills.

Example mechanisms include the following:

- In-house training (both organizational and project)
- External training
- Staffing and new hires
- External skill acquisition

The choice of in-house training or outsourced training for needed knowledge and skills is determined by the availability of training expertise, the project's schedule, and business objectives.

4. Incorporate selected mechanisms into the project plan.

SP 2.6 Plan Stakeholder Involvement

Plan the involvement of identified stakeholders.

Stakeholders are identified from all phases of the project lifecycle by identifying the people and functions that need to be represented in the project and describing their relevance and the degree of interaction for project activities. A two-dimensional matrix with stakeholders along one axis and project activities along the other axis is a convenient format for accomplishing this identification. Relevance of the stakeholder to the activity in a particular project phase and the amount of interaction expected would be shown at the intersection of the project phase activity axis and the stakeholder axis.

Stakeholders can include operational users and project participants as well as potential suppliers. When acquiring products that must interoperate with other products, the acquirer plans the involvement of stakeholders from other projects or communities to ensure the delivered product can perform as required in its intended environment. Such planning often includes steps for establishing and maintaining supplier agreements with these stakeholders (e.g., interagency and intercompany agreements, memorandums of understanding, and memorandums of agreement).

For inputs of stakeholders to be useful, careful selection of relevant stakeholders is necessary. For each major activity, identify stakeholders who are affected by the activity and those who have expertise that is needed to conduct the activity. This list of relevant stakeholders will probably change as the project moves through phases of the project lifecycle. It is important, however, to ensure that relevant stakeholders in the latter phases of the lifecycle have early input to requirements and design decisions that affect them.

Examples of the type of material that should be included in a plan for stakeholder interaction include the following:

- List of all relevant stakeholders
- Rationale for stakeholder involvement
- Roles and responsibilities of relevant stakeholders with respect to the project, by project lifecycle phase
- Relationships among stakeholders
- Relative importance of the stakeholder to the success of the project, by project lifecycle phase
- Resources (e.g., training, materials, time, and funding) needed to ensure stakeholder interaction
- Schedule for the phasing of stakeholder interaction

Implementing this specific practice relies on shared or exchanged information with the previous Plan Needed Knowledge and Skills specific practice.

Typical Work Products

1. Stakeholder involvement plan

SP 2.7 Plan Transition to Operations and Support

Plan transition to operations and support.

Planning for transition must be considered part of initial planning for the project.

Transition and support plans include the approach for introducing and maintaining readiness, sustainment, and the operational capability of the products delivered by the supplier. Plans for transitioning to operations and support include assignment of responsibility for transition to operations and support of the product, as well as all activities needed to manage the transition and to support the product in its intended environment (e.g., definition of transition readiness criteria agreed to by relevant stakeholders). These plans may include reasonable accommodations for potential risks and for the evolution of acquired products and their eventual removal from operational use.

Transition to operations and support plans typically include the following:

- Processes and procedures for the transition to operations and support
- Evaluation methods and acceptance criteria for transitioning the product to operations and support
- Readiness criteria for the product
- Readiness criteria for the operations organization
- Readiness criteria for the product support organization
- Expectations for supplier execution of the transition
- Warranty expectations for the acquired product
- Transition of intellectual property or other acquirer assets to the acquirer's designated repository
- Resolution steps if any problems are encountered

If support is to be provided by an organization different from the supplier, a sufficient overlap period should be included in the plan.

Typically, the acquirer develops initial transition and support plans and then reviews and approves more detailed transition and support plans.

Refer to the Agreement Management process area for more information about acceptance criteria and accepting the product.

Refer to the Acquisition Technical Management process area for more information about evaluation methods for the product.

Typical Work Products

1. Transition to operations and support plans

Subpractices

1. Determine the transition scope and objectives.
2. Determine transition requirements and criteria.
3. Determine transition responsibilities and resources to include post-transition support enhancements and lifecycle considerations.
4. Determine configuration management needs of the transition.
5. Determine training needs for operations and support.

SP 2.8

Establish the Project Plan

Establish and maintain the overall project plan.

A documented plan that addresses all relevant planning items is necessary to achieve the mutual understanding, commitment, and performance of individuals, groups, and organizations that must execute or support the plans. The plan generated for the project defines all aspects of the effort, tying together the following in a logical manner: project lifecycle considerations; technical and management tasks; budgets and schedules; milestones; data management, risk identification; resource and skill requirements; and stakeholder identification and interaction. Infrastructure descriptions include responsibility and authority relationships for project staff, management, and support organizations.

The project plan may include multiple plans such as staffing plans, stakeholder involvement plans, measurement and analysis plans, monitoring and control plans, solicitation plans, agreement management plans, risk mitigation plans, transition plans, quality assurance plans, and configuration management plans. Regardless of form, the plan or plans should address the acquisition strategy as well as the cradle-to-grave considerations for the project and product to be acquired.

Examples of plans that have been used in the U.S. Department of Defense community include the following:

- Integrated Master Plan—an event-driven plan that documents significant accomplishments with pass/fail criteria for both business and technical elements of the project and that ties each accomplishment to a key project event.
- Integrated Master Schedule—an integrated and networked multi-layered schedule of project tasks required to complete the work effort documented in a related Integrated Master Plan.
- Systems Engineering Management Plan—a plan that details the integrated technical effort across the project.
- Systems Engineering Master Schedule—an event-based schedule that contains a compilation of key technical accomplishments, each with measurable criteria, requiring successful completion to pass identified events.
- Systems Engineering Detailed Schedule—a detailed, time-dependent, task-oriented schedule that associates dates and milestones with the Systems Engineering Master Schedule.

Typical Work Products

1. Overall project plan

SG 3 Obtain Commitment to the Plan

Commitments to the project plan are established and maintained.

To be effective, plans require commitment by those responsible for implementing and supporting the plan.

Refer to the Solicitation and Supplier Agreement Development process area for more information about supplier agreements and finalizing supplier plans.

SP 3.1 Review Plans That Affect the Project

Review all plans that affect the project to understand project commitments.

Plans developed in other process areas typically contain information similar to that called for in the overall project plan. These plans may provide additional detailed guidance and should be compatible with and support the overall project plan to indicate who has the authority, responsibility, accountability, and control. All plans that affect the project should be reviewed to ensure they contain a common understanding of the scope, objectives, roles, and relationships that are required for the project to be successful. Many of these plans are described by the Plan the Process generic practice.

The project may have a hierarchy of plans (e.g., risk mitigation plans, transition plans, quality assurance plans, and configuration management plans). In addition, stakeholder plans (e.g., operational, test, support, and supplier plans) must be reviewed to ensure consistency among all project participants. Acquirer review of plans must include reviewing cross-supplier dependencies.

Typical Work Products

1. Record of the reviews of plans that affect the project

SP 3.2 Reconcile Work and Resource Levels

Adjust the project plan to reconcile available and estimated resources.

To establish a project that is feasible, obtain commitment from relevant stakeholders and reconcile differences between estimates and available resources. Reconciliation is typically accomplished by lowering or deferring technical performance requirements, negotiating more resources, finding ways to increase productivity, outsourcing, adjusting the staff skill mix, or revising all plans that affect the project or its schedules.

During supplier selection and negotiation of the supplier agreement, the acquirer reconciles overall project work and resource levels based on proposals from the supplier. Following completion of the supplier agreement, the acquirer incorporates supplier plans at an appropriate level of detail into the project plan to support the alignment of plans. For example, an acquirer may incorporate major supplier milestones, deliverables, and reviews.

Typical Work Products

1. Revised methods and corresponding estimating parameters (e.g., better tools and the use of off-the-shelf components)
2. Renegotiated budgets
3. Revised schedules
4. Revised requirements list
5. Renegotiated stakeholder agreements

SP 3.3 Obtain Plan Commitment

Obtain commitment from relevant stakeholders responsible for performing and supporting plan execution.

Obtaining commitment involves interaction among all relevant stakeholders, both internal and external to the project. The individual or group making a commitment should have confidence that the work can be performed within cost, schedule, and performance constraints.

Often, a provisional commitment is adequate to allow the effort to begin and to permit research to be performed to increase confidence to the appropriate level needed to obtain a full commitment.

Typical Work Products

1. Documented requests for commitments
2. Documented commitments

Subpractices

1. Identify needed support and negotiate commitments with relevant stakeholders.

The WBS can be used as a checklist for ensuring that commitments are obtained for all tasks.

The plan for stakeholder interaction should identify all parties from whom commitment should be obtained.

2. Document all organizational commitments, both full and provisional, ensuring the appropriate level of signatories.

Commitments must be documented to ensure a consistent mutual understanding and for tracking and maintenance. Provisional commitments should be accompanied by a description of risks associated with the relationship.

3. Review internal commitments with senior management, as appropriate.
4. Review external commitments with senior management, as appropriate.

Management may have the necessary insight and authority to reduce risks associated with external commitments.

5. Identify commitments regarding interfaces between project elements and other projects and organizational units so that these commitments can be monitored.

Well-defined interface specifications form the basis for commitments.

PROCESS AND PRODUCT QUALITY ASSURANCE

A Support Process Area at Maturity Level 2

Purpose

The purpose of Process and Product Quality Assurance (PPQA) is to provide staff and management with objective insight into processes and associated work products.

Introductory Notes

The Process and Product Quality Assurance process area involves the following activities:

- Objectively evaluating performed processes, work products, and services against applicable process descriptions, standards, and procedures
- Identifying and documenting noncompliance issues
- Providing feedback to project staff and managers on the results of quality assurance activities
- Ensuring that noncompliance issues are addressed

The Process and Product Quality Assurance process area supports the delivery of high-quality products and services by providing project staff and managers at all levels with appropriate visibility into, and feedback on, processes and associated work products throughout the life of the project.

The acquirer evaluates critical acquirer work products, acquirer processes, results of supplier process quality assurance, and supplier deliverables. For example, process and product quality assurance ensures that the solicitation package was developed using standard processes agreed to by the organization and that it conforms to all applicable policies. The acquirer may review results of supplier quality assurance activities for selected supplier processes to ensure that the supplier is following its own processes.

Typically, selected supplier processes are critical processes, such as engineering or verification processes, where the supplier is required through the supplier agreement to follow project-specified standards. In exceptional cases, the acquirer may directly perform process and product quality assurance for selected supplier processes. The acquirer and supplier periodically share quality assurance issues and findings that are of mutual interest.

The practices in the Process and Product Quality Assurance process area ensure that planned processes are implemented, while the practices in the Acquisition Verification process area ensure that specified requirements are satisfied. These two process areas may on occasion address the same work product but from different perspectives. Projects should take advantage of the overlap in order to minimize duplication of effort while taking care to maintain separate perspectives.

Objectivity in process and product quality assurance evaluations is critical to the success of the project. (See the definition of “objectively evaluate” in the glossary.) Objectivity is achieved by both independence and the use of criteria. A combination of methods providing evaluations against criteria by those not producing the work product is often used. Less formal methods can be used to provide broad day-to-day coverage. More formal methods can be used periodically to assure objectivity.

Examples of ways to perform objective evaluations include the following:

- Formal audits by organizationally separate quality assurance organizations
- Peer reviews, which may be performed at various levels of formality
- In-depth review of work at the place it is performed (i.e., desk audits)
- Distributed review and comment of work products

Traditionally, a quality assurance group that is independent of the project provides objectivity. However, another approach may be appropriate in some organizations to implement the process and product quality assurance role without that kind of independence.

For example, in an organization with an open, quality-oriented culture, the process and product quality assurance role may be performed, partially or completely, by peers; and the quality assurance function may be embedded in the process. For small organizations, this might be the most feasible approach.

If quality assurance is embedded in the process, several issues must be addressed to ensure objectivity. Everyone performing quality assurance activities should be trained. Those performing quality assurance activities for a work product should be separate from those directly involved in developing or maintaining the work product. An independent reporting channel to the appropriate level of organizational management must be available so that noncompliance issues can be escalated as necessary.

For example, when implementing peer reviews as an objective evaluation method, the following issues must be addressed:

- Members are trained and roles are assigned for people attending the peer reviews.
- A member of the peer review who did not produce this work product is assigned to perform the quality assurance role.
- Checklists are available to support the quality assurance activity.
- Defects are recorded as part of the peer review report and are tracked and escalated outside the project when necessary.

Quality assurance should begin in the early phases of a project to establish plans, processes, standards, and procedures that will add value to the project and satisfy the requirements of the project and organizational policies. Those performing quality assurance participate in establishing plans, processes, standards, and procedures to ensure that they fit project needs and that they will be usable for performing quality assurance evaluations. In addition, processes and associated work products to be evaluated during the project are designated. This designation may be based on sampling or on objective criteria that are consistent with organizational policies, project requirements, and needs.

When noncompliance issues are identified, they are first addressed in the project and resolved there if possible. Noncompliance issues that cannot be resolved in the project are escalated to an appropriate level of management for resolution.

This process area applies primarily to evaluations of project activities and work products, but it also applies to other activities and work products, such as training organizational support groups. For these activities and work products, the term *project* should be appropriately interpreted.

It also applies to the reviews of supplier process quality results as defined in the supplier agreement. For example, the supplier agreement can require the supplier to provide detailed appraisal results of mandatory, acquirer-scaled CMMI for Development appraisals of supplier processes.

Related Process Areas

*Refer to the **Solicitation and Supplier Agreement Development** process area for more information about specifying evaluation of selected supplier processes and work products.*

*Refer to the **Agreement Management** process area for more information about managing conformance to supplier agreements.*

Refer to the Acquisition Verification process area for more information about the verification of acquirer work products.

Refer to the Acquisition Technical Management process area for more information about evaluating the technical solution.

Specific Goal and Practice Summary

SG 1 Objectively Evaluate Processes and Work Products

SP 1.1 Objectively Evaluate Processes

SP 1.2 Objectively Evaluate Work Products and Services

SG 2 Provide Objective Insight

SP 2.1 Communicate and Ensure the Resolution of Noncompliance Issues

SP 2.2 Establish Records

Specific Practices by Goal

SG 1 Objectively Evaluate Processes and Work Products

Adherence of the performed process and associated work products and services to applicable process descriptions, standards, and procedures is objectively evaluated.

SP 1.1 Objectively Evaluate Processes

Objectively evaluate designated performed processes against applicable process descriptions, standards, and procedures.

Objectivity in quality assurance evaluations is critical to the success of the project. A description of the quality assurance reporting chain and how it ensures objectivity should be defined.

The description of the quality assurance reporting chain is extended to include the relationship between the acquirer and suppliers. It is important to ensure that acquirer and supplier processes comply with applicable statutory and regulatory requirements.

The acquirer evaluates the project's execution of acquirer processes, including interactions with suppliers, and reviews evaluation reports provided by suppliers to determine if they follow their processes. There should be sufficient process quality assurance to detect noncompliance issues as early as possible that may affect the acquirer's or supplier's ability to successfully deliver products to the customer.

Through the supplier agreement, the acquirer should retain the right to audit supplier processes if there is an indication that suppliers are not following acceptable processes.

Typical Work Products

1. Evaluation reports
2. Noncompliance reports
3. Corrective actions

Typical Supplier Deliverables

1. Reports resulting from evaluations carried out by the supplier
2. Noncompliance reports
3. Corrective actions

Subpractices

1. Promote an environment (created as part of project management) that encourages employee participation in identifying and reporting quality issues.
2. Establish and maintain clearly stated criteria for evaluations.
3. Use the stated criteria to evaluate performed processes for adherence to process descriptions, standards, and procedures.

The supplier regularly provides process evaluation reports as defined in the supplier agreement.

4. Identify each noncompliance found during the evaluation.

Analyze results of monitoring selected acquirer processes to detect issues as early as possible that may affect the supplier's ability to satisfy requirements of its agreement.

5. Identify lessons learned that could improve processes for future products and services.

SP 1.2 Objectively Evaluate Work Products and Services

Objectively evaluate designated work products and services against applicable process descriptions, standards, and procedures.

In addition to objectively evaluating critical acquirer work products, the acquirer uses objective acceptance criteria to evaluate supplier deliverables throughout the project lifecycle. The acquirer's acceptance criteria for supplier deliverables are consistent with project objectives and sufficient to allow the supplier to satisfactorily demonstrate that the product conforms to contractual requirements.

Refer to the Acquisition Verification process area for more information about verifying selected work products.

Typical Work Products

1. Evaluation reports
2. Noncompliance reports
3. Corrective actions

Subpractices

1. Select work products to be evaluated based on documented sampling criteria if sampling is used.
2. Establish and maintain clearly stated criteria for the evaluation of work products.
3. Use the stated criteria during evaluations of work products.
4. Evaluate work products before they are delivered to the customer.
5. Evaluate work products at selected milestones in their development.
6. Perform in-progress or incremental evaluations of work products and services against process descriptions, standards, and procedures.
7. Identify each case of noncompliance found during evaluations.
8. Identify lessons learned that could improve processes for future products and services.

SG 2 Provide Objective Insight

Noncompliance issues are objectively tracked and communicated, and resolution is ensured.

SP 2.1 Communicate and Ensure the Resolution of Noncompliance Issues

Communicate quality issues and ensure the resolution of noncompliance issues with the staff and managers.

Noncompliance issues are problems identified in evaluations that reflect a lack of adherence to applicable standards, process descriptions, or procedures. The status of noncompliance issues provides an indication of quality trends. Quality issues include noncompliance issues and trend analysis results.

When noncompliance issues cannot be resolved in the project, use established escalation mechanisms to ensure that the appropriate level of management can resolve the issue. Track noncompliance issues to resolution.

Noncompliance issues of both the acquirer and supplier are tracked and resolved.

Typical Work Products

1. Corrective action reports
2. Evaluation reports
3. Quality trends
4. Acquirer feedback to suppliers

Typical Supplier Deliverables

1. Corrective actions

Subpractices

1. Resolve each noncompliance with the appropriate members of the staff where possible.

The acquirer involves suppliers when resolving noncompliance issues, as appropriate.

2. Document noncompliance issues when they cannot be resolved in the project.

Examples of ways to resolve a noncompliance in the project include the following:

- Fixing the noncompliance
- Changing the process descriptions, standards, or procedures that were violated
- Obtaining a waiver to cover the noncompliance

3. Escalate noncompliance issues that cannot be resolved in the project to the appropriate level of management designated to receive and act on noncompliance issues.
4. Analyze noncompliance issues to see if there are quality trends that can be identified and addressed.
5. Ensure that relevant stakeholders are aware of results of evaluations and quality trends in a timely manner.
6. Periodically review open noncompliance issues and trends with the manager designated to receive and act on noncompliance issues.
7. Track noncompliance issues to resolution.

SP 2.2 Establish Records

Establish and maintain records of quality assurance activities.

Typical Work Products

1. Evaluation logs
2. Quality assurance reports
3. Status reports of corrective actions
4. Reports of quality trends

Subpractices

1. Record process and product quality assurance activities in sufficient detail so that status and results are known.
2. Revise the status and history of quality assurance activities as necessary.

QUANTITATIVE PROJECT MANAGEMENT

A Project Management Process Area at Maturity Level 4

Purpose

The purpose of Quantitative Project Management (QPM) is to quantitatively manage the project's defined process to achieve the project's established quality and process-performance objectives.

Introductory Notes

The Quantitative Project Management process area involves the following activities:

- Establishing and maintaining the project's quality and process-performance objectives
- Identifying suitable subprocesses that compose the project's defined process based on historical stability and capability data found in process-performance baselines or models
- Selecting subprocesses within the project's defined process to be statistically managed
- Monitoring the project to determine whether the project's objectives for quality and process performance are being satisfied, and identifying appropriate corrective action
- Selecting measures and analytic techniques to be used in statistically managing selected subprocesses
- Establishing and maintaining an understanding of the variation of selected subprocesses using selected measures and analytic techniques
- Monitoring the performance of selected subprocesses to determine whether they are capable of satisfying their quality and process-performance objectives, and identifying corrective action
- Recording statistical and quality management data in the organization's measurement repository

The quality and process-performance objectives, measures, and baselines identified here are developed as described in the Organizational Process Performance process area. Subsequently, the results of performing the processes associated with the Quantitative Project Management process area (e.g., measurement definitions and measurement data) become part of the organizational process assets referred to in the Organizational Process Performance process area.

To effectively address the specific practices in this process area, the organization must have already established a set of standard processes and related organizational process assets, such as the organization's measurement repository and the organization's process asset library for use by each project in establishing its defined process.

The project's defined process is a set of subprocesses that form an integrated and coherent lifecycle for the project. It is established, in part, through selecting and tailoring processes from the organization's set of standard processes. (See the definition of "defined process" in the glossary.)

The project should ensure that supplier effort and progress measurements are made available. Establishing effective relationships with suppliers is also necessary for the successful implementation of this process area's specific practices.

The acquirer uses quantitative methods to manage its work and to gain insight into supplier work and products. In addition to its own quantitative data, the acquirer uses quantitative data provided by the supplier as specified in the supplier agreement to address the specific practices in this process area.

Process performance is a measure of actual process results achieved. Process performance is characterized by both process measures (e.g., effort, cycle time, and defect removal efficiency) and product measures (e.g., reliability, defect density, and response time).

Subprocesses are defined components of a larger defined process. The subprocesses themselves may be further decomposed into other subprocesses and process elements.

An essential element of quantitative management is having confidence in estimates (i.e., being able to predict the extent to which the project can fulfill its quality and process-performance objectives).

Subprocesses to be statistically managed are chosen based on identified needs for predictable performance. (See the definitions of "statistically managed process," "quality and process-performance objective," and "quantitatively managed process" in the glossary.)

Another essential element of quantitative management is understanding the nature and extent of the variation experienced in process performance, and recognizing when the project's actual performance may not be adequate to achieve the project's quality and process-performance objectives.

Statistical management involves statistical thinking and the correct use of a variety of statistical techniques such as run charts, control charts, confidence intervals, prediction intervals, and tests of hypotheses.

Quantitative management uses data from statistical management to help the project predict whether it will be able to achieve its quality and process-performance objectives and identify what corrective action should be taken.

This process area applies to managing a project, but the concepts found here also apply to managing other groups and functions. Applying these concepts to managing other groups and functions may not necessarily contribute to achieving the organization's business objectives but may help these groups and functions control their processes.

Examples of other groups and functions that could benefit from using this process area include the following:

- Quality assurance
- Process definition and improvement
- Effort reporting
- Customer complaint handling
- Problem tracking and reporting

Related Process Areas

Refer to the Project Monitoring and Control process area for more information about monitoring and controlling the project and taking corrective action.

Refer to the Measurement and Analysis process area for more information about establishing measurable objectives, specifying measures and analyses to be performed, obtaining and analyzing measures, and reporting results.

Refer to the Organizational Process Performance process area for more information about the organization's quality and process-performance objectives, process-performance analyses, process-performance baselines, and process-performance models.

Refer to the Organizational Process Definition process area for more information about organizational process assets, including the organization's measurement repository.

Refer to the Integrated Project Management process area for more information about establishing and maintaining the project's defined process.

Refer to the Causal Analysis and Resolution process area for more information about identifying causes of defects and other problems and taking action to prevent them from occurring in the future.

Refer to the Organizational Innovation and Deployment process area for more information about selecting and deploying improvements that support the organization's quality and process-performance objectives.

Refer to the Solicitation and Supplier Agreement Development process area for more information about establishing reporting requirements for supplier measurement results and quantitative data in the supplier agreement.

Specific Goal and Practice Summary

SG 1 Quantitatively Manage the Project

- SP 1.1 Establish the Project's Objectives
- SP 1.2 Compose the Defined Process
- SP 1.3 Select Subprocesses to Be Statistically Managed
- SP 1.4 Manage Project Performance

SG 2 Statistically Manage Subprocess Performance

- SP 2.1 Select Measures and Analytic Techniques
- SP 2.2 Apply Statistical Methods to Understand Variation
- SP 2.3 Monitor the Performance of Selected Subprocesses
- SP 2.4 Record Statistical Management Data

Specific Practices by Goal

SG 1 Quantitatively Manage the Project

The project is quantitatively managed using quality and process-performance objectives.

SP 1.1 Establish the Project's Objectives

Establish and maintain the project's quality and process-performance objectives.

When establishing the project's quality and process-performance objectives, it is often useful to think ahead about which processes from the organization's set of standard processes will be included in the project's defined process and what the historical data indicate regarding their process performance. These considerations will help in establishing realistic objectives for the project. Later, as the project's actual performance becomes known and more predictable, objectives may need to be revised.

The acquirer establishes the project's quality and process-performance objectives based on objectives of the organization, the customer, and other relevant stakeholders. The acquirer may also establish quality and process-performance objectives for supplier deliverables. These quantitative quality and process-performance objectives for the supplier are documented in the supplier agreement. The acquirer typically expects the supplier to execute its processes and apply its process-performance models toward achieving these objectives.

Typical Work Products

1. The project's quality and process-performance objectives

Subpractices

1. Review the organization's objectives for quality and process performance.

The intent of this review is to ensure that the project understands the broader business context in which the project must operate. The project's objectives for quality and process performance are developed in the context of these overarching organizational objectives.

Refer to the Organizational Process Performance process area for more information about the organization's quality and process-performance objectives.

2. Identify the quality and process-performance needs and priorities of the customer, suppliers, end users, and other relevant stakeholders.

Examples of quality and process-performance attributes for which needs and priorities might be identified include the following:

- Functionality
- Reliability
- Maintainability
- Usability
- Duration
- Predictability
- Timeliness
- Accuracy

3. Identify how process performance is to be measured.

Consider whether measures established by the organization are adequate for assessing progress in fulfilling customer, end-user, and other stakeholder needs and priorities. It may be necessary to supplement these measures with additional ones.

Refer to the Measurement and Analysis process area for more information about defining measures.

4. Define and document measurable quality and process-performance objectives for the project.

Defining and documenting objectives for the project involve the following:

- Incorporating the organization's quality and process-performance objectives
- Writing objectives that reflect the quality and process-performance needs and priorities of the customer, end users, and other stakeholders, and the way these objectives should be measured

Examples of quality attributes for which objectives might be written include the following:

- Mean time between failures
- Critical resource utilization
- Number and severity of defects in the released product
- Number and severity of customer complaints concerning the provided service

Examples of process-performance attributes for which objectives might be written include the following:

- Percentage of defects removed by product verification activities (perhaps by type of verification, such as peer reviews and testing)
- Defect escape rates
- Number and density of defects (by severity) found during the first year following product delivery (or start of service)
- Cycle time
- Percentage of rework time

5. Derive interim objectives for each lifecycle phase, as appropriate, to monitor progress toward achieving the project's objectives.

An example of a method to predict future results of a process is the use of process-performance models to predict latent defects in the delivered product using interim measures of defects identified during product verification activities (e.g., peer reviews and testing).

6. Resolve conflicts among the project's quality and process-performance objectives (e.g., if one objective cannot be achieved without compromising another).

Resolving conflicts involves the following activities:

- Setting relative priorities for objectives
- Considering alternative objectives in light of long-term business strategies as well as short-term needs
- Involving the customer, end users, senior management, project management, and other relevant stakeholders in tradeoff decisions
- Revising objectives as necessary to reflect results of conflict resolution

7. Establish traceability to the project's quality and process-performance objectives from their sources.

Examples of sources of objectives include the following:

- Requirements
- The organization's quality and process-performance objectives
- The customer's quality and process-performance objectives
- Business objectives
- Discussions with customers and potential customers
- Market surveys

An example of a method to identify and trace these needs and priorities is Quality Function Deployment (QFD).

8. Define and negotiate quality and process-performance objectives for suppliers.

Refer to the Solicitation and Supplier Agreement Development process area for more information about incorporating project quality and process-performance objectives into solicitation packages and into supplier agreements.

9. Revise the project's quality and process-performance objectives as necessary.

SP 1.2 Compose the Defined Process

Select subprocesses that compose the project's defined process based on historical stability and capability data.

Refer to the Integrated Project Management process area for more information about establishing and maintaining the project's defined process.

Refer to the Organizational Process Definition process area for more information about the organization's process asset library, which might include a process element of known and needed capability.

Refer to the Organizational Process Performance process area for more information about the organization's process-performance baselines and process-performance models.

Subprocesses are identified from process elements in the organization's set of standard processes and process artifacts in the organization's process asset library.

These subprocesses may include those used for interacting with a supplier (e.g., negotiating a supplier agreement and conducting supplier reviews).

Typical Work Products

1. Criteria used in identifying which subprocesses are valid candidates for inclusion in the project's defined process
2. Candidate subprocesses for inclusion in the project's defined process
3. Subprocesses to be included in the project's defined process
4. Identified risks when selected subprocesses lack a process-performance history

Subpractices

1. Establish the criteria to use in identifying which subprocesses are valid candidates for use.

Identification may be based on the following:

- Quality and process-performance objectives
- Existence of process-performance data
- Product line standards
- Project lifecycle models
- Customer requirements
- Laws and regulations

2. Determine whether subprocesses that are to be statistically managed and were obtained from the organizational process assets are suitable for statistical management.

A subprocess may be more suitable for statistical management if it has a history of the following:

- Stable performance in previous comparable instances
- Process-performance data that satisfy the project's quality and process-performance objectives

Historical data are primarily obtained from the organization's process-performance baselines. However, these data may not be available for all subprocesses.

3. Analyze the interaction of subprocesses to understand relationships among subprocesses and measured attributes of the subprocesses.

Examples of analysis techniques include system dynamics models and simulations.

4. Identify the risk when no subprocess is available that is known to be capable of satisfying quality and process-performance objectives (i.e., no capable subprocess is available or the capability of the subprocess is not known).

Even when a subprocess has not been selected to be statistically managed, historical data and process-performance models may indicate that the subprocess is not capable of satisfying quality and process-performance objectives.

Refer to the Risk Management process area for more information about identifying and analyzing risks.

SP 1.3 Select Subprocesses to Be Statistically Managed

Select subprocesses of the project's defined process to be statistically managed.

Selecting subprocesses to be statistically managed is often a concurrent and iterative process of identifying applicable project and organization quality and process-performance objectives, selecting subprocesses, and identifying process and product attributes to measure and control. Often the selection of a process, quality and process-performance objective, or measurable attribute will constrain the selection of the other two. For example, if a particular process is selected, measurable attributes and quality and process-performance objectives may be constrained by that process.

Typical Work Products

1. Quality and process-performance objectives to be addressed by statistical management
2. Criteria used in selecting which subprocesses will be statistically managed
3. Subprocesses to be statistically managed
4. Identified process and product attributes of selected subprocesses that should be measured and controlled

Subpractices

1. Identify which of the project's quality and process-performance objectives will be statistically managed.

2. Identify criteria to be used in selecting subprocesses that are the main contributors to achieving identified quality and process-performance objectives and for which predictable performance is important.

Examples of sources for criteria used in selecting subprocesses include the following:

- Customer requirements related to quality and process performance
- Quality and process-performance objectives established by the customer
- Quality and process-performance objectives established by the organization
- The organization's performance baselines and models
- Stable performance of the subprocess on other projects
- Laws and regulations

3. Select subprocesses to be statistically managed using selection criteria.

It may not be possible to statistically manage some subprocesses (e.g., where new subprocesses and technologies are being piloted). In other cases, it may not be economically justifiable to apply statistical techniques to certain subprocesses.

4. Identify product and process attributes of selected subprocesses to be measured and controlled.

Examples of product and process attributes include the following:

- Defect density
- Cycle time
- Test coverage

SP 1.4 Manage Project Performance

Monitor the project to determine whether the project's objectives for quality and process performance will be satisfied, and identify corrective action, as appropriate.

Refer to the Measurement and Analysis process area for more information about analyzing and using measures.

A prerequisite for such a determination is that the selected subprocesses of the project's defined process are statistically managed and their process capability is understood. Specific practices of specific goal 2 provide detail on statistically managing selected subprocesses.

The acquirer monitors the performance of selected subprocesses to assess whether the project is on track in achieving its quality and process-performance objectives. These subprocesses include those that involve interaction with a supplier. This selective monitoring provides the acquirer with insight into project and supplier performance in order to predict the likelihood of achieving project objectives for quality and process performance. The acquirer uses this information to manage the project and to initiate corrective actions in time to meet project objectives.

Typical Work Products

1. Estimates (i.e., predictions) of the achievement of the project's quality and process-performance objectives
2. Documentation of risks in achieving the project's quality and process-performance objectives
3. Documentation of actions needed to address deficiencies in achieving project objectives

Typical Supplier Deliverables

1. Supplier process-performance data for quality and process-performance objectives and expected service levels

Subpractices

1. Periodically review the performance and capability of each subprocess selected to be statistically managed to appraise progress toward achieving the project's quality and process-performance objectives.

The process capability of each selected subprocess is determined with respect to that subprocess' established quality and process-performance objectives. These objectives are derived from the project's quality and process-performance objectives, which are defined for the project as a whole.
2. Periodically review actual results achieved against established interim objectives for each phase of the project lifecycle to appraise progress toward achieving the project's quality and process-performance objectives.
3. Track supplier results for achieving their quality and process-performance objectives.
4. Use process-performance models calibrated with obtained measures of critical attributes to estimate progress toward achieving the project's quality and process-performance objectives.

Process-performance models are used to estimate progress toward achieving objectives that cannot be measured until a future phase in the project lifecycle. An example is the use of process-performance models to predict latent defects in the delivered product using interim measures of defects identified during peer reviews.

Refer to the Organizational Process Performance process area for more information about process-performance models.

Calibration of the process-performance models is based on results obtained from performing the previous subpractices.

5. Identify and manage risks associated with achieving the project's quality and process-performance objectives.

Refer to the Risk Management process area for more information about identifying and managing risks.

Example sources of risks include the following:

- Inadequate stability and capability data in the organization's measurement repository
- Subprocesses having inadequate performance or capability
- Suppliers not achieving their quality and process-performance objectives
- Lack of visibility into supplier capability
- Inaccuracies in the organization's process-performance models for predicting future performance
- Deficiencies in predicted process performance (estimated progress)
- Other identified risks associated with identified deficiencies

6. Determine and document actions needed to address deficiencies in achieving the project's quality and process-performance objectives.

The intent of these actions is to plan and deploy the right set of activities, resources, and schedule to place the project back on a path toward achieving its objectives.

Examples of actions that can be taken to address deficiencies in achieving the project's objectives include the following:

- Changing quality and process-performance objectives so that they are within the expected range of the project's defined process
- Improving the implementation of the project's defined process to reduce its normal variability (Reducing variability may bring the project's performance within the objectives without having to move the mean.)
- Adopting new subprocesses and technologies that have the potential for satisfying objectives and managing associated risks
- Identifying the risk and risk mitigation strategies for deficiencies
- Terminating the project

Refer to the Project Monitoring and Control process area for more information about taking corrective action.

SG 2 Statistically Manage Subprocess Performance

The performance of selected subprocesses within the project's defined process is statistically managed.

This specific goal describes an activity critical to achieving the Quantitatively Manage the Project specific goal of this process area. The specific practices under this specific goal describe how to statistically manage subprocesses whose selection was described in specific practices under specific goal 1. When selected subprocesses are statistically managed, their capability to achieve their objectives can be determined. By these means, it is possible to predict whether the project will be able to achieve its objectives, which is key to quantitatively managing the project.

SP 2.1 Select Measures and Analytic Techniques

Select measures and analytic techniques to be used in statistically managing selected subprocesses.

Refer to the Measurement and Analysis process area for more information about establishing measurable objectives; specifying the measures and analyses to be performed; obtaining, analyzing, and updating measures; and reporting results.

Typical Work Products

1. Definitions of measures and analytic techniques to be used in (or proposed for) statistically managing subprocesses
2. Operational definitions of measures, their collection points in subprocesses, and how the integrity of measures will be determined

3. Traceability of measures back to the project's quality and process-performance objectives
4. Instrumented organizational support environment that supports automatic data collection

Subpractices

1. Identify common measures from the organizational process assets that support statistical management.

Refer to the Organizational Process Definition process area for more information about common measures.

Product lines or other stratification criteria may categorize common measures.

2. Identify additional measures that may be needed for this instance to cover critical product and process attributes of the selected subprocesses.

In some cases, measures may be research oriented. Such measures should be explicitly identified.

3. Identify the measures that are appropriate for statistical management.

Critical criteria for selecting statistical management measures include the following:

- Controllable (e.g., Can a measure's values be changed by changing how the subprocess is implemented?)
- Adequate performance indicator (e.g., Is the measure a good indicator of how well the subprocess is performing relative to the objectives of interest?)

Examples of subprocess measures include the following:

- Requirements volatility
- Ratios of estimated to measured values of planning parameters (e.g., size, cost, and schedule)
- Coverage and efficiency of peer reviews
- Test coverage and efficiency
- Effectiveness of training (e.g., percent of planned training completed and test scores)
- Reliability
- Percentage of total defects inserted or found in different phases of the project lifecycle
- Percentage of total effort expended in different phases of the project lifecycle

4. Specify the operational definitions of measures, their collection points in subprocesses, and how the integrity of measures will be determined.

Operational definitions are stated in precise and unambiguous terms. They address two important criteria:

 - Communication: What has been measured, how it was measured, what are the units of measure, and what has been included or excluded?
 - Repeatability: Is the measurement repeatable, given the same definition, to get the same results?
5. Analyze the relationship of identified measures to the objectives of the organization and its projects, and derive objectives that state target measures or ranges to be met for each measured attribute of each selected subprocess.
6. Instrument the organizational or project support environment to support collection, derivation, and analysis of statistical measures.

This instrumentation is based on the following:

- Description of the organization's set of standard processes
- Description of the project's defined process
- Capabilities of the organizational or project support environment

7. Identify appropriate statistical analysis techniques that are expected to be useful in statistically managing the selected subprocesses.

The concept of "one size does not fit all" applies to statistical analysis techniques. What makes a particular technique appropriate is not just the type of measures but, more important, how the measures will be used and whether the situation warrants applying that technique. The appropriateness of the selection may need to be reviewed from time to time.

Examples of statistical analysis techniques are given in the next specific practice.

8. Revise measures and statistical analysis techniques as necessary.

SP 2.2

Apply Statistical Methods to Understand Variation

Establish and maintain an understanding of the variation of selected subprocesses using selected measures and analytic techniques.

Refer to the Measurement and Analysis process area for more information about collecting, analyzing, and using measurement results.

Understanding variation is achieved, in part, by collecting and analyzing process and product measures so that special causes of variation can be identified and addressed to achieve predictable performance.

A special cause of process variation is characterized by an unexpected change in process performance. Special causes are also known as *assignable causes* because they can be identified, analyzed, and addressed to prevent recurrence.

The identification of special causes of variation is based on departures from the system of common causes of variation. These departures can be identified by the presence of extreme values or other identifiable patterns in data collected from the subprocess or associated work products. Typically, knowledge of variation and insight about potential sources of anomalous patterns are needed to detect special causes of variation.

Sources of anomalous patterns of variation may include the following:

- Lack of process compliance
- Undistinguished influences of multiple underlying subprocesses on the data
- Ordering or timing of activities within the subprocess
- Uncontrolled inputs to the subprocess
- Environmental changes during subprocess execution
- Schedule pressure
- Inappropriate sampling or grouping of data

Typical Work Products

1. Collected measurements
2. Natural bounds of process performance for each measured attribute of each selected subprocess
3. Process performance compared to the natural bounds of process performance for each measured attribute of each selected subprocess

Typical Supplier Deliverables

1. Collected supplier measurements
2. Natural bounds of supplier process performance for each measured attribute of each selected subprocess
3. Supplier process performance compared to the natural bounds of process performance for each measured attribute of each selected subprocess

Subpractices

1. Establish trial natural bounds for subprocesses having suitable historical performance data.

Refer to the Organizational Process Performance process area for more information about organizational process-performance baselines.

Natural bounds of an attribute are the range within which variation normally occurs. All processes show some variation in process and product measures each time they are executed. The issue is whether this variation is due to common causes of variation in the normal performance of the process or to some special cause that can and should be identified and removed.

When a subprocess is initially executed, suitable data for establishing trial natural bounds are sometimes available from prior instances of the subprocess or comparable subprocesses, process-performance baselines, or process-performance models. Typically, these data are contained in the organization's measurement repository. As the subprocess is executed, data specific to that instance are collected and used to update and replace the trial natural bounds. However, if the subprocess has been materially tailored, or if conditions are materially different from those in previous instantiations, data in the repository may not be relevant and should not be used.

In some cases, there may be no comparable historical data (e.g., when introducing a new subprocess, when entering a new application domain, or when significant changes have been made to the subprocess). In such cases, trial natural bounds will have to be made from early process data of this subprocess. These trial natural bounds must then be refined and updated as subprocess execution continues.

Examples of criteria for determining whether data are comparable include the following:

- Product lines
- Application domain
- Work product and task attributes (e.g., size of product)
- Size of project

2. Collect data, as defined by selected measures, on subprocesses as they execute.
3. Calculate the natural bounds of process performance for each measured attribute.

Examples of statistical techniques for calculating natural bounds include the following:

- Control charts
- Confidence intervals (for parameters of distributions)
- Prediction intervals (for future outcomes)

4. Identify special causes of variation.

An example of a criterion for detecting a special cause of process variation in a control chart is a data point that falls outside 3-sigma control limits.

The criteria for detecting special causes of variation are based on statistical theory and experience and depend on economic justification. As criteria are added, special causes are more likely to be identified if they are present, but the likelihood of false alarms also increases.

5. Analyze special cause of process variation to determine the reasons the anomaly occurred.

Examples of techniques for analyzing the reasons for special causes of variation include the following:

- Cause-and-effect (fishbone) diagrams
- Designed experiments
- Control charts (applied to subprocess inputs or lower level subprocesses)
- Subgrouping (Analyzing the same data segregated into smaller groups based on an understanding of how the subprocess was implemented facilitates isolation of special causes.)

Some anomalies may simply be extremes of the underlying distribution rather than problems. Those implementing a subprocess are usually the ones best able to analyze and understand special causes of variation.

6. Determine the corrective action to be taken when special causes of variation are identified.

Removing a special cause of process variation does not change the underlying subprocess. It addresses an error in the way the subprocess is executed.

Refer to the Project Monitoring and Control process area for more information about taking corrective action.

7. Recalculate natural bounds for each measured attribute of the selected subprocesses as necessary.

Recalculating the (statistically estimated) natural bounds is based on measured values that signify that the subprocess has changed, not on expectations or arbitrary decisions.

Examples of when natural bounds may need to be recalculated include the following:

- There are incremental improvements to the subprocess
- New tools are deployed for the subprocess
- A new subprocess is deployed
- The collected measures suggest that the subprocess mean has permanently shifted or subprocess variation has permanently changed

SP 2.3

Monitor the Performance of Selected Subprocesses

Monitor the performance of selected subprocesses to determine their capability to satisfy their quality and process-performance objectives, and identify corrective action as necessary.

The intent of this specific practice is to do the following:

- Statistically determine process behavior expected from the subprocess
- Appraise the probability that the subprocess will meet its quality and process-performance objectives
- Identify the corrective action to be taken based on a statistical analysis of process-performance data

Corrective action may include renegotiating affected project objectives, identifying and implementing alternative subprocesses, or identifying and measuring lower level subprocesses to achieve greater detail in performance data.

These actions are intended to help the project use a more capable process. (See the definition of “capable process” in the glossary.)

A prerequisite for comparing the capability of a selected subprocess against its quality and process-performance objectives is that the measured attributes of the subprocess indicate that its performance is stable and predictable.

Process capability is analyzed for those subprocesses and measured attributes for which (derived) objectives are established. Not all subprocesses or measured attributes that are statistically managed are analyzed regarding process capability.

Historical data may be inadequate for initially determining whether the subprocess is capable. It also is possible that the estimated natural bounds for subprocess performance may shift away from quality and process-performance objectives. In either case, statistical control implies monitoring capability as well as stability.

Typical Work Products

1. Natural bounds of process performance for each selected subprocess compared to its established (derived) objectives
2. The process capability of each subprocess
3. The actions needed to address deficiencies in the process capability of each subprocess

Typical Supplier Deliverables

1. Actions needed to address deficiencies in supplier process performance or the quality of deliverables

Subpractices

1. Compare quality and process-performance objectives to the natural bounds of the measured attribute.

This comparison provides an appraisal of the process capability for each measured attribute of a subprocess. These comparisons can be displayed graphically in ways that relate the estimated natural bounds to the objectives or as process capability indices, which summarize the relationship of objectives to natural bounds.

2. Monitor changes in quality and process-performance objectives and the process capability of the selected subprocess.
3. Identify and document deficiencies in subprocess capability.
4. Determine and document actions needed to address deficiencies in subprocess capability.

Examples of actions that can be taken when the performance of a selected subprocess does not satisfy its objectives include the following:

- Re-deriving quality and process-performance objectives for each selected subprocess so that they can be met given the performance of the selected subprocesses
- Improving the implementation of the existing subprocess to reduce its normal variability (reducing variability may bring natural bounds within the objectives without having to move the mean)
- Adopting new process elements, subprocesses, and technologies that have the potential to satisfy objectives and manage associated risks
- Identifying risks and risk mitigation strategies for each deficiency in subprocess capability

Refer to the Project Monitoring and Control process area for more information about taking corrective action.

SP 2.4

Record Statistical Management Data

Record statistical and quality management data in the organization's measurement repository.

Refer to the Measurement and Analysis process area for more information about managing and storing data, measurement definitions, and results.

Refer to the Organizational Process Definition process area for more information about the organization's measurement repository.

Typical Work Products

1. Statistical and quality management data recorded in the organization's measurement repository

REQUIREMENTS MANAGEMENT

A Project Management Process Area at Maturity Level 2

Purpose

The purpose of Requirements Management (REQM) is to manage requirements of the project's products and product components and to identify inconsistencies between those requirements and the project's plans and work products.

Introductory Notes

Requirements management processes manage all requirements received or generated by the project, including both technical and nontechnical requirements as well as requirements levied on the project by the organization.

In particular, if the Acquisition Requirements Development process area is implemented, the resulting processes will generate customer and contractual requirements to be managed by requirements management processes. When the Requirements Management and the Acquisition Requirements Development process areas are both implemented, their associated processes may be closely tied and performed concurrently.

The project takes appropriate steps to ensure that the agreed-on set of requirements is managed to support the planning and execution needs of the project. When a project receives requirements from an approved requirements provider, these requirements are reviewed with the requirements provider to resolve issues and prevent misunderstanding before requirements are incorporated into project plans. Once the requirements provider and the requirements receiver reach an agreement, commitment to the requirements is obtained from project participants. The project manages changes to requirements as they evolve and identifies inconsistencies that occur among plans, work products, and requirements.

Part of managing requirements is documenting requirements changes and their rationale and maintaining bidirectional traceability between source requirements and all product and product component requirements. (See the definition of "bidirectional traceability" in the glossary.)

Throughout the process areas, where we use the terms *product* and *product component*, they are intended to include service and service component and should be interpreted in that way.

Related Process Areas

Refer to the Acquisition Requirements Development process area for more information about transforming stakeholder needs into customer requirements and allocating requirements to supplier deliverables.

Refer to the Project Planning process area for more information about how project plans reflect requirements and must be revised as requirements change.

Refer to the Configuration Management process area for more information about baselines and controlling changes to requirements documents.

Refer to the Project Monitoring and Control process area for more information about tracking and controlling activities and work products that are based on requirements and taking appropriate corrective action.

Refer to the Risk Management process area for more information about identifying and handling risks associated with requirements.

Specific Goal and Practice Summary

SG 1 Manage Requirements

- SP 1.1 Understand Requirements
- SP 1.2 Obtain Commitment to Requirements
- SP 1.3 Manage Requirements Changes
- SP 1.4 Maintain Bidirectional Traceability of Requirements
- SP 1.5 Identify Inconsistencies Between Project Work and Requirements

Specific Practices by Goal

SG 1 Manage Requirements

Requirements are managed and inconsistencies with project plans and work products are identified.

The project maintains a current and approved set of requirements over the life of the project by doing the following:

- Managing all changes to requirements
- Maintaining relationships among requirements, project plans, and work products
- Identifying inconsistencies among requirements, project plans, and work products
- Taking corrective action

Refer to the Project Monitoring and Control process area for more information about taking corrective action.

Requirements management typically includes directly managing changes to customer and contractual requirements developed by the acquirer and overseeing the supplier's requirements management process. Requirements changes may result in changes to the supplier agreement.

SP 1.1 Understand Requirements

Develop an understanding with requirements providers on the meaning of requirements.

To avoid requirements creep, criteria are established to designate appropriate channels or official sources from which to receive requirements. Those receiving requirements conduct analyses of them with the provider to ensure that a compatible, shared understanding is reached on the meaning of requirements. The result of these analyses and dialog is an agreed-to set of requirements.

Typical Work Products

1. Lists of criteria for distinguishing appropriate requirements providers
2. Criteria for evaluation and acceptance of requirements
3. Results of analyses against criteria
4. An agreed-to set of requirements

Subpractices

1. Establish criteria for distinguishing appropriate requirements providers.
2. Establish objective criteria for the evaluation and acceptance of requirements.

Lack of evaluation and acceptance criteria often results in inadequate verification, costly rework, or customer rejection.

Examples of evaluation and acceptance criteria include the following:

- Clearly and properly stated
- Complete
- Consistent with one another
- Uniquely identified
- Appropriate to implement
- Verifiable (testable)
- Traceable

3. Analyze requirements to ensure that established criteria are met.

4. Reach an understanding of requirements with requirements providers so that project participants can commit to them.

SP 1.2 Obtain Commitment to Requirements

Obtain commitment to requirements from project participants.

Refer to the Project Monitoring and Control process area for more information about monitoring the commitments made.

The previous specific practice dealt with reaching an understanding with requirements providers. This specific practice deals with agreements and commitments among those who must carry out activities necessary to implement requirements. Requirements evolve throughout the project. As requirements evolve, this specific practice ensures that project participants commit to the current and approved requirements and the resulting changes in project plans, activities, and work products.

Changes to requirements may lead to changes in supplier agreements. These changes must be agreed on by the acquirer and supplier after appropriate negotiations.

Typical Work Products

1. Requirements impact assessments
2. Documented commitments to requirements and requirements changes

Typical Supplier Deliverables

1. Supplier requirements impact assessments

Subpractices

1. Assess the impact of requirements on existing commitments.
2. Negotiate and record commitments.

Changes to existing commitments should be negotiated before project participants commit to a requirement or requirement change.

The acquirer negotiates commitments with the customer and supplier before committing to requirement changes.

SP 1.3 Manage Requirements Changes

Manage changes to requirements as they evolve during the project.

Refer to the Configuration Management process area for more information about maintaining and controlling the requirements baseline and making requirements and change data available to the project.

During the project, requirements change for a variety of reasons. As needs change and as work proceeds, changes may have to be made to existing requirements. It is essential to manage these additions and changes efficiently and effectively. To effectively analyze the impact of changes, it is necessary that the source of each requirement is known and the rationale for the change is documented. The project may, however, want to track appropriate measures of requirements volatility to judge whether new or revised controls are necessary.

If contractual requirements defined in the supplier agreement are affected by the changes, the supplier agreement also must be aligned with the changed requirements.

Typical Work Products

1. Requirements change requests
2. Requirements change impact reports
3. Requirements status
4. Requirements database
5. Requirements decision database

Typical Supplier Deliverables

1. Requirements change requests
2. Requirements change impact reports

Subpractices

1. Document all requirements and requirements changes that are given to or generated by the project.
2. Maintain a requirements change history, including the rationale for changes.

Maintaining the change history helps track requirements volatility.

3. Evaluate the impact of requirement changes from the standpoint of relevant stakeholders.
4. Make requirements and change data available to the project.

SP 1.4

Maintain Bidirectional Traceability of Requirements

Maintain bidirectional traceability among requirements and work products.

The intent of this specific practice is to maintain the bidirectional traceability of requirements. (See the definition of “bidirectional traceability” in the glossary.) When requirements are managed well, traceability can be established from a source requirement to its lower level requirements and from those lower level requirements back to their source requirements. Such bidirectional traceability helps determine whether all source requirements have been completely addressed and whether all lower level requirements can be traced to a valid source.

Requirements traceability can also cover relationships to other entities such as intermediate and final work products, changes in design documentation, and test plans. Traceability can cover horizontal relationships, such as across interfaces, as well as vertical relationships. Traceability is particularly needed in conducting the impact assessment of requirements changes on project activities and work products.

The supplier maintains comprehensive bidirectional traceability to requirements defined in the supplier agreement by the acquirer, and the acquirer verifies that traceability. The acquirer maintains bidirectional traceability between customer requirements and contractual requirements.

Typical Work Products

1. Requirements traceability matrix
2. Requirements tracking system

Typical Supplier Deliverables

1. Comprehensive requirements traceability matrix managed by the supplier as required by the supplier agreement

Subpractices

1. Maintain requirements traceability to ensure that the source of lower level (derived) requirements is documented.

Traceability from customer to contractual requirements is maintained by the acquirer. Traceability from contractual requirements to derived or additional requirements is maintained by the supplier.

2. Maintain requirements traceability from a requirement to its derived requirements and allocation to functions, interfaces, objects, people, processes, and work products.
3. Generate a requirements traceability matrix.

A comprehensive traceability matrix, tracing from customer requirements to contractor requirements is maintained by the acquirer. A comprehensive traceability matrix, tracing from contractual requirements to lower level requirements is maintained by the supplier.

SP 1.5 Identify Inconsistencies Between Project Work and Requirements

Identify inconsistencies between project plans and work products and requirements.

Refer to the Project Monitoring and Control process area for more information about monitoring and controlling project plans and work products for consistency with requirements and taking corrective actions when necessary.

This specific practice finds inconsistencies between requirements and project plans and work products and initiates corrective actions to resolve them.

Corrective actions taken by the project to resolve inconsistencies may also result in changes to project plans and supplier agreements.

Typical Work Products

1. Documentation of inconsistencies between requirements and project plans and work products, including sources and conditions
2. Corrective actions

Subpractices

1. Review project plans, activities, and work products for consistency with requirements and changes made to them.
2. Identify the source of the inconsistency.
3. Identify changes that must be made to plans and work products resulting from changes to the requirements baseline.
4. Initiate corrective actions.

RISK MANAGEMENT

A Project Management Process Area at Maturity Level 3

Purpose

The purpose of Risk Management (RSKM) is to identify potential problems before they occur so that risk-handling activities can be planned and invoked as needed across the life of the product or project to mitigate adverse impacts on achieving objectives.

Introductory Notes

Risk management is a continuous, forward-looking process that is an important part of project management. Risk management should address issues that could endanger achievement of critical objectives. A continuous risk management approach effectively anticipates and mitigates risks that may have a critical impact on a project.

Effective risk management includes early and aggressive risk identification through collaboration and the involvement of relevant stakeholders as described in the stakeholder involvement plan addressed in the Project Planning process area. Strong leadership across all relevant stakeholders is needed to establish an environment for free and open disclosure and discussion of risk.

Risk management must consider both internal and external sources of cost, schedule, performance, and other risks. Early and aggressive detection of risk is important because it is typically easier, less costly, and less disruptive to make changes and correct work efforts during earlier, rather than the later, phases of the project.

When the project identifies and assesses project risks during project planning and manages risks throughout the life of the project, risk identification includes identifying risks associated with the acquisition process and the use of a supplier to perform project work. Initially, the acquisition strategy identifies risks associated with an acquisition. The approach to the acquisition is planned based on those risks. As the project progresses to the selection of a supplier, risks specific to the supplier's technical and management approach become important to the success of the acquisition.

These risks refer to the capability of the supplier to meet contractual requirements, including schedules and cost targets. When the project selects a supplier and awards the supplier agreement, the acquirer continues to manage project risks, including risks related to the supplier meeting its contractual requirements. Typically the acquirer does not manage risks being addressed or managed by the supplier.

Risk management can be divided into three parts: defining a risk management strategy; identifying and analyzing risks; and handling identified risks, including the implementation of risk mitigation plans as needed.

Both the acquirer and supplier must understand project risks and how to modify the risk management strategy and plans as a project progresses through its lifecycle. Managing project risks requires a close partnership between the acquirer and supplier. Both must share appropriate risk management documentation, understand the risks, and develop and execute risk management activities.

The complexity of an acquirer-supplier relationship increases the need for early and aggressive risk identification. For example, acquirer capabilities, supplier experience working with the acquirer, financial stability of the supplier, and availability of well-defined dispute resolution processes all influence the risk of a project.

As represented in the Project Planning and Project Monitoring and Control process areas, organizations initially may focus on risk identification for awareness, and react to the realization of these risks as they occur. The Risk Management process area describes an evolution of these specific practices to systematically plan, anticipate, and mitigate risks to proactively minimize their impact on the project.

Although the primary emphasis of the Risk Management process area is on the project, these concepts can also be applied to manage organizational risks.

Related Process Areas

Refer to the Project Planning process area for more information about identifying project risks and planning the involvement of relevant stakeholders.

Refer to the Project Monitoring and Control process area for more information about monitoring project risks.

Refer to the Decision Analysis and Resolution process area for more information about using a formal evaluation process to evaluate alternatives for the selection and mitigation of identified risks.

Refer to the Solicitation and Supplier Agreement Development process area for more information about establishing supplier agreements.

Specific Goal and Practice Summary

SG 1 Prepare for Risk Management

- SP 1.1 Determine Risk Sources and Categories
- SP 1.2 Define Risk Parameters
- SP 1.3 Establish a Risk Management Strategy

SG 2 Identify and Analyze Risks

- SP 2.1 Identify Risks
- SP 2.2 Evaluate, Categorize, and Prioritize Risks

SG 3 Mitigate Risks

- SP 3.1 Develop Risk Mitigation Plans
- SP 3.2 Implement Risk Mitigation Plans

Specific Practices by Goal

SG 1 Prepare for Risk Management

Preparation for risk management is conducted.

Prepare for risk management by establishing and maintaining a strategy for identifying, analyzing, and mitigating risks. Typically, this strategy is documented in a risk management plan. The risk management strategy addresses specific actions and the management approach used to apply and control the risk management program. The strategy typically includes identifying sources of risk, the scheme used to categorize risks, and parameters used to evaluate, bound, and control risks for effective handling.

SP 1.1 Determine Risk Sources and Categories

Determine risk sources and categories.

Identifying risk sources provides a basis for systematically examining changing situations over time to uncover circumstances that impact the ability of the project to meet its objectives. Risk sources are both internal and external to the project. As the project progresses, additional sources of risk may be identified. Establishing categories for risks provides a mechanism for collecting and organizing risks as well as ensuring appropriate scrutiny and management attention to risks that can have serious consequences on meeting project objectives.

Acquirers initially identify and categorize risk sources and categories for the project and refine those sources and categories over time (e.g., schedule, cost, sourcing, contract management, supplier execution, technology readiness, human safety, reliability related risks and other issues outside the control of the acquirer). The supplier is also a source of risk (e.g., financial stability of the supplier and the possibility of the supplier's acquisition by another organization).

Typical Work Products

1. Risk source lists (external and internal)
2. Risk categories list

Subpractices

1. Determine risk sources.

Risk sources are fundamental drivers that cause risks in a project or organization. There are many sources of risks, both internal and external to a project. Risk sources identify where risks may originate.

Typical internal and external risk sources include the following:

- Uncertain requirements
- Unprecedented efforts (i.e., estimates unavailable)
- Infeasible design
- Unavailable technology
- Unrealistic schedule estimates or allocation
- Inadequate staffing and skills
- Cost or funding issues
- Uncertain or inadequate subcontractor capability
- Uncertain or inadequate supplier capability
- Inadequate communication with customers
- Disruptions to the continuity of operations

Many of these sources of risk are often accepted without adequately planning for them. Early identification of both internal and external sources of risk can lead to early identification of risks. Risk mitigation plans can then be implemented early in the project to preclude occurrence of risks or reduce consequences of their occurrence.

2. Determine risk categories.

Risk categories are the “bins” used for collecting and organizing risks. Identifying risk categories aids the future consolidation of activities in risk mitigation plans.

The following factors may be considered when determining risk categories:

- Phases of the project's lifecycle model (e.g., requirements, design, manufacturing, test and evaluation, delivery, and disposal)
- Types of processes used
- Types of products used
- Project management risks (e.g., contract risks, budget/cost risks, schedule risks, resource risks, performance risks, and supportability risks)
- Supplier risks (e.g., financial viability of the supplier and the geographic location of supplier resources)
- Product safety, security, and reliability

A risk taxonomy can be used to provide a framework for determining risk sources and categories.

SP 1.2 Define Risk Parameters

Define parameters used to analyze and categorize risks and to control the risk management effort.

Parameters for evaluating, categorizing, and prioritizing risks include the following:

- Risk likelihood (i.e., probability of risk occurrence)
- Risk consequence (i.e., impact and severity of risk occurrence)
- Thresholds to trigger management activities

Risk parameters are used to provide common and consistent criteria for comparing risks to be managed. Without these parameters, it is difficult to gauge the severity of an unwanted change caused by a risk and to prioritize the actions required for risk mitigation planning.

Acquirers should document the parameters used to analyze and categorize risks so they are available for reference throughout the life of the project since circumstances change over time. Using these parameters, risks can easily be re-categorized and analyzed when changes occur.

The acquirer may use tools such as *failure mode and effects analysis* to examine risks such as potential failures in products or processes. A tool may also be used to evaluate risk management priorities for mitigating known threat vulnerabilities.

Typical Work Products

1. Risk evaluation, categorization, and prioritization criteria
2. Risk management requirements (e.g., control and approval levels and reassessment intervals)

Subpractices

1. Define consistent criteria for evaluating and quantifying risk likelihood and severity levels.

Consistently used criteria (e.g., bounds on likelihood and severity levels) allow impacts of different risks to be commonly understood, to receive the appropriate level of scrutiny, and to obtain the management attention warranted. In managing dissimilar risks (e.g., personnel safety versus environmental pollution), it is important to ensure consistency in the end result (e.g., a high risk of environmental pollution is as important as a high risk to personnel safety).

2. Define thresholds for each risk category.

For each risk category, thresholds can be established to determine acceptability or unacceptability of risks, prioritization of risks, or triggers for management action.

Examples of thresholds include the following:

- Project-wide thresholds could be established to involve senior management when product costs exceed 10 percent of the target cost or when cost performance indices (CPIs) fall below 0.95.
- Schedule thresholds could be established to involve senior management when schedule performance indices (SPIs) fall below 0.95.
- Performance thresholds could be established to involve senior management when specified key items (e.g., processor utilization or average response times) exceed 125 percent of the intended design.

For each identified risk, establish points at which more aggressive risk monitoring is employed or to signal the implementation of risk mitigation plans. These points can be redefined later in the project as necessary.

3. Define bounds on the extent to which thresholds are applied against or within a category.

There are few limits to which risks can be assessed in either a quantitative or qualitative fashion. Definition of bounds (or boundary conditions) can be used to help define the extent of the risk management effort and avoid excessive resource expenditures. Bounds may include the exclusion of a risk source from a category. These bounds can also exclude any condition that occurs less than a given frequency.

SP 1.3 Establish a Risk Management Strategy

Establish and maintain the strategy to be used for risk management.

A comprehensive risk management strategy addresses items such as the following:

- The scope of the risk management effort
- Methods and tools to be used for risk identification, risk analysis, risk mitigation, risk monitoring, and communication
- Project-specific sources of risks
- How risks are to be organized, categorized, compared, and consolidated
- Parameters used for taking action on identified risks, including likelihood, consequence, and thresholds
- Risk mitigation techniques to be used, such as prototyping, piloting, simulation, alternative designs, or evolutionary development
- The definition of risk measures used to monitor the status of risks
- Time intervals for risk monitoring or reassessment

The risk management strategy should be guided by a common vision of success that describes desired future project outcomes in terms of the product delivered, its cost, and its fitness for the task. The risk management strategy is often documented in an organizational or project risk management plan. This strategy is reviewed with relevant stakeholders to promote commitment and understanding.

A risk management strategy must be developed early in the project, so that relevant risks are identified and managed aggressively. The acquisition strategy evolves based on risk identification and analysis. Early identification and assessment of critical risks allows the acquirer to formulate risk handling approaches and streamline the project definition and solicitation around critical product and process risks.

Typical Work Products

1. Project risk management strategy

SG 2 Identify and Analyze Risks

Risks are identified and analyzed to determine their relative importance.

The degree of risk affects the resources assigned to handle the risk and the timing of when appropriate management attention is required.

Risk analysis entails identifying risks from identified internal and external sources and evaluating each identified risk to determine its likelihood and consequences. Risk categorization, based on an evaluation against established risk categories and criteria developed for the risk management strategy, provides information needed for risk handling. Related risks may be grouped to enable efficient handling and effective use of risk management resources.

SP 2.1 Identify Risks

Identify and document risks.

Identifying potential issues, hazards, threats, and vulnerabilities that could negatively affect work efforts or plans is the basis for sound and successful risk management. Risks must be identified and described understandably before they can be analyzed and managed properly. Risks are documented in a concise statement that includes the context, conditions, and consequences of risk occurrence.

Risk identification should be an organized, thorough approach to seek out probable or realistic risks that may affect achieving objectives. To be effective, risk identification should not attempt to address every possible event regardless of how improbable it may be. Using categories and parameters developed in the risk management strategy and identified sources of risk can provide the discipline and streamlining appropriate for risk identification. Identified risks form a baseline for initiating risk management activities. Risks should be reviewed periodically to reexamine possible sources of risk and changing conditions to uncover sources and risks previously overlooked or nonexistent when the risk management strategy was last updated.

Risk identification focuses on identifying risks, not placement of blame. The results of risk identification activities should never be used by management to evaluate the performance of individuals.

There are many methods used for identifying risks. Typical identification methods include the following:

- Examine each element of the project work breakdown structure.
- Conduct a risk assessment using a risk taxonomy.
- Interview subject matter experts.
- Review risk management efforts from similar products.
- Examine lessons-learned documents or databases.
- Examine design specifications and agreement requirements.

Some risks are identified by examining the supplier's WBS, product, and processes using the categories and parameters developed in the risk management strategy. Risks can be identified in many areas (e.g., requirements, technology, design, testing, vulnerability to threats, and lifecycle costs). An examination of the project in these areas can help to develop or refine the acquisition strategy and the risk-sharing structure between the acquirer and supplier.

The acquirer considers risks associated with a supplier's capability (e.g., meeting schedule and cost requirements for the project), including potential risks to the acquirer's intellectual capital or security vulnerabilities introduced by using a supplier.

Typical Work Products

1. List of identified risks, including the context, conditions, and consequences of risk occurrence

Typical Supplier Deliverables

1. List of identified risks, including the context, conditions, and consequences of risk occurrence

Subpractices

1. Identify the risks associated with cost, schedule, and performance.

Cost, schedule, and performance risks should be examined in the acquirer's intended environment to the extent that they impact project objectives. Potential risks may be discovered that are outside the scope of project objectives but vital to customer interests. For example, risks in development costs, product acquisition costs, cost of spare (or replacement) products, and product disposition (or disposal) costs have design implications. The customer may not have considered the full cost of supporting a fielded product or using a delivered service. The customer should be informed of such risks, but actively managing those risks may not be necessary. Mechanisms for making such decisions should be examined at project and organization levels and put in place if deemed appropriate, especially for risks that impact the project's ability to verify and validate the product.

In addition to the cost risks identified above, other cost risks may include those associated with funding levels, funding estimates, and distributed budgets.

Schedule risks may include risks associated with planned activities, key events, and milestones.

Performance risks may include risks associated with the following:

- Requirements
- Analysis and design
- Application of new technology
- Physical size
- Shape
- Weight
- Manufacturing and fabrication
- Functional performance and operation
- Verification
- Validation
- Performance maintenance attributes

Performance maintenance attributes are those characteristics that enable an in-use product or service to provide required performance, such as maintaining safety and security performance.

There are other risks that do not fall into cost, schedule, or performance categories.

Examples of these other risks include those related to the following:

- Strikes
- Diminishing sources of supply
- Technology cycle time
- Competition

2. Review environmental elements that may impact the project.

Risks to a project that frequently are missed include those supposedly outside the scope of the project (i.e., the project does not control whether they occur but can mitigate their impact), such as weather, natural or manmade disasters that affect the continuity of operations, political changes, and telecommunications failures.

3. Review all elements of the work breakdown structure as part of identifying risks to help ensure that all aspects of the work effort have been considered.
4. Review all elements of the project plan as part of identifying risks to help ensure that all aspects of the project have been considered.

Refer to the Project Planning process area for more information about identifying project risks.

5. Document the context, conditions, and potential consequences of each risk.

Risk statements are typically documented in a standard format that contains the risk context, conditions, and consequences of occurrence. The risk context provides additional information about the risk such as the relative time frame of the risk, the circumstances or conditions surrounding the risk that has brought about the concern, and any doubt or uncertainty.

6. Identify the relevant stakeholders associated with each risk.

SP 2.2 Evaluate, Categorize, and Prioritize Risks

Evaluate and categorize each identified risk using defined risk categories and parameters, and determine its relative priority.

The evaluation of risks is needed to assign a relative importance to each identified risk and is used in determining when appropriate management attention is required. Often it is useful to aggregate risks based on their interrelationships and develop options at an aggregate level. When an aggregate risk is formed by a roll up of lower level risks, care must be taken to ensure that important lower level risks are not ignored.

Collectively, the activities of risk evaluation, categorization, and prioritization are sometimes called a *risk assessment* or *risk analysis*.

The acquirer should conduct a risk assessment before solicitation to evaluate if the project can achieve its technical, schedule, and budget constraints. Technical, schedule, and cost risks should be discussed with potential suppliers before the solicitation is released. Using this approach, critical risks inherent in the project can be identified and addressed in the solicitation.

Typical Work Products

1. List of risks and their assigned priority

Typical Supplier Deliverables

1. List of risks and their assigned priority

Subpractices

1. Evaluate identified risks using defined risk parameters.

Each risk is evaluated and assigned values according to defined risk parameters, which may include likelihood, consequence (severity or impact), and thresholds. The assigned risk parameter values can be integrated to produce additional measures, such as risk exposure, which can be used to prioritize risks for handling.

Often, a scale with three to five values is used to evaluate both likelihood and consequence.

Likelihood, for example, can be categorized as remote, unlikely, likely, highly likely, or a near certainty.

Example categories for consequence include the following:

- Low
- Medium
- High
- Negligible
- Marginal
- Significant
- Critical
- Catastrophic

Probability values are frequently used to quantify likelihood. Consequences are generally related to cost, schedule, environmental impact, or human measures (e.g., labor hours lost and severity of injury).

Risk evaluation is often a difficult and time-consuming task. Specific expertise or group techniques may be needed to assess risks and gain confidence in the prioritization. In addition, priorities may require reevaluation as time progresses.

2. Categorize and group risks according to defined risk categories.

Risks are categorized into defined risk categories, providing a means to review them according to their source, taxonomy, or project component. Related or equivalent risks may be grouped for efficient handling. The cause-and-effect relationships between related risks are documented.

An acquirer's risk categories may include sourcing, contract management, and supplier execution, in addition to project management, technology, and requirements.

3. Prioritize risks for mitigation.

A relative priority is determined for each risk based on assigned risk parameters. Clear criteria should be used to determine risk priority. Risk prioritization helps to determine the most effective areas to which resources for risks mitigation can be applied with the greatest positive impact to the project.

SG 3 Mitigate Risks

Risks are handled and mitigated, as appropriate, to reduce adverse impacts on achieving objectives.

The steps in handling risks include developing risk-handling options, monitoring risks, and performing risk-handling activities when defined thresholds are exceeded. Risk mitigation plans are developed and implemented for selected risks to proactively reduce the potential impact of risk occurrence. Risk mitigation planning can also include contingency plans to deal with the impact of selected risks that may occur despite attempts to mitigate them. Risk parameters used to trigger risk-handling activities are defined by the risk management strategy.

SP 3.1 Develop Risk Mitigation Plans

Develop a risk mitigation plan for the most important risks to the project as defined by the risk management strategy.

A critical component of a risk mitigation planning is developing alternative courses of action, workarounds, and fallback positions, and a recommended course of action for each critical risk. The risk mitigation plan for a given risk includes techniques and methods used to avoid, reduce, and control the probability of risk occurrence, the extent of damage incurred should the risk occur (sometimes called a *contingency plan*), or both. Risks are monitored and when they exceed established thresholds, risk mitigation plans are deployed to return the impacted effort to an acceptable risk level. If the risk cannot be mitigated, a contingency plan can be invoked. Both risk mitigation and contingency plans often are generated only for selected risks for which consequences of the risks are high or unacceptable; other risks may be accepted and simply monitored.

Options for handling risks typically include alternatives such as the following:

- Risk avoidance: changing or lowering requirements while still meeting user needs
- Risk control: taking active steps to minimize risks
- Risk transfer: reallocating requirements to lower risks
- Risk monitoring: watching and periodically reevaluating the risk for changes in assigned risk parameters
- Risk acceptance: acknowledging risk but not taking action

Often, especially for high risks, more than one approach to handling a risk should be generated.

For example, in the case of an event that disrupts the continuity of operations, approaches to risk management can include establishing the following:

- Resource reserves to respond to disruptive events
- Lists of available back-up equipment
- Back-up personnel for key personnel
- Plans for and results of testing emergency response systems
- Posted procedures for emergencies
- Disseminated lists of key contacts and information resources for emergencies

In many cases, risks are accepted or watched. Risk acceptance is usually done when the risk is judged too low for formal mitigation or when there appears to be no viable way to reduce the risk. If a risk is accepted, the rationale for this decision should be documented. Risks are watched when there is an objectively defined, verifiable, and documented threshold of performance, time, or risk exposure (i.e., the combination of likelihood and consequence) that will trigger risk mitigation planning or invoke a contingency plan.

Thresholds for supplier risks that affect the project (e.g., schedule, quality, or risk exposure due to supplier risks) are specified in the supplier agreement along with escalation procedures if thresholds are exceeded.

Adequate consideration should be given early to technology demonstrations, models, simulations, pilots, and prototypes as part of risk mitigation planning.

Typical Work Products

1. Documented handling options for each identified risk
2. Risk mitigation plans
3. Contingency plans
4. Disaster recovery or continuity plans
5. List of those responsible for tracking and addressing each risk

Typical Supplier Deliverables

1. Documented handling options for each identified risk
2. Risk mitigation plans
3. Contingency plans
4. Disaster recovery or continuity plans
5. List of those responsible for tracking and addressing each risk

Subpractices

1. Determine the levels and thresholds that define when a risk becomes unacceptable and triggers the execution of a risk mitigation plan or contingency plan.

Risk level (derived using a risk model) is a measure combining the uncertainty of reaching an objective with the consequences of failing to reach the objective.

Risk levels and thresholds that bound planned or acceptable performance must be clearly understood and defined to provide a means with which risk can be understood. Proper categorization of risk is essential for ensuring an appropriate priority based on severity and the associated management response. There may be multiple thresholds employed to initiate varying levels of management response. Typically, thresholds for the execution of risk mitigation plans are set to engage before the execution of contingency plans.

2. Identify the person or group responsible for addressing each risk.
3. Determine the cost-to-benefit ratio of implementing the risk mitigation plan for each risk.

Risk mitigation activities should be examined for benefits they provide versus resources they will expend. Just like any other design activity, alternative plans may need to be developed and costs and benefits of each alternative assessed. The most appropriate plan is selected for implementation.

4. Develop an overall risk mitigation plan for the project to orchestrate the implementation of individual risk mitigation and contingency plans.

The complete set of risk mitigation plans may not be affordable. A tradeoff analysis should be performed to prioritize risk mitigation plans for implementation.

5. Develop contingency plans for selected critical risks in the event their impacts are realized.

Risk mitigation plans are developed and implemented as needed to proactively reduce risks before they become problems. Despite best efforts, some risks may be unavoidable and will become problems that impact the project. Contingency plans can be developed for critical risks to describe actions a project may take to deal with the occurrence of this impact. The intent is to define a proactive plan for handling the risk, either to reduce the risk (mitigation) or respond to the risk (contingency), but in either event to manage the risk.

Some risk management literature may consider contingency plans a synonym or subset of risk mitigation plans. These plans also may be addressed together as risk-handling or risk action plans.

SP 3.2 Implement Risk Mitigation Plans

Monitor the status of each risk periodically and implement the risk mitigation plan, as appropriate.

To effectively control and manage risks during the work effort, follow a proactive program to regularly monitor risks and the status and results of risk-handling actions. The risk management strategy defines the intervals at which risk status should be revisited. This activity may result in the discovery of new risks or new risk-handling options that can require replanning and reassessment. In either event, acceptability thresholds associated with the risk should be compared to the risk status to determine the need for implementing a risk mitigation plan.

The acquirer shares selected risks with the supplier. Risks associated with the acquisition process are tracked and resolved or controlled until mitigated. This monitoring includes risks that may be escalated by the supplier.

Typical Work Products

1. Updated lists of risk status
2. Updated assessments of risk likelihood, consequence, and thresholds
3. Updated list of risk-handling options
4. Updated list of actions taken to handle risks
5. Risk mitigation plans

Typical Supplier Deliverables

1. Updated list of risk status
2. Updated assessments of risk likelihood, consequence, and thresholds
3. Updated list of risk-handling options
4. Updated list of actions taken to handle risks
5. Risk mitigation plans

Subpractices

1. Monitor risk status.

After a risk mitigation plan is initiated, the risk is still monitored. Thresholds are assessed to check for the potential execution of a contingency plan.

A mechanism for monitoring should be employed.

2. Provide a method for tracking open risk-handling action items to closure.

Refer to the Project Monitoring and Control process area for more information about tracking action items.

3. Invoke selected risk-handling options when monitored risks exceed defined thresholds.

Often, risk handling is only performed for risks judged to be "high" and "medium." The risk-handling strategy for a given risk may include techniques and methods to avoid, reduce, and control the likelihood of the risk or the extent of damage incurred should the risk (anticipated event or situation) occur or both. In this context, risk handling includes both risk mitigation plans and contingency plans.

Risk-handling techniques are developed to avoid, reduce, and control adverse impact to project objectives and to bring about acceptable outcomes in light of probable impacts. Actions generated to handle a risk require proper resource loading and scheduling in plans and baseline schedules. This replanning must closely consider the effects on adjacent or dependent work initiatives or activities.

Refer to the Project Monitoring and Control process area for more information about revising the project plan.

4. Establish a schedule or period of performance for each risk-handling activity that includes a start date and anticipated completion date.
5. Provide a continued commitment of resources for each plan to allow the successful execution of risk-handling activities.
6. Collect performance measures on risk-handling activities.

SOLICITATION AND SUPPLIER AGREEMENT DEVELOPMENT

An Acquisition Process Area at Maturity Level 2

Purpose

The purpose of **Solicitation and Supplier Agreement Development (SSAD)** is to prepare a solicitation package, select one or more suppliers to deliver the product or service, and establish and maintain the supplier agreement.

Introductory Notes

The **Solicitation and Supplier Agreement Development** process area provides a set of practices that enables the acquirer to initialize and formalize a relationship with the supplier for the successful execution of the project. A supplier agreement is an agreement between the acquirer and supplier. This agreement may be a contract, license, or memorandum of agreement. The acquired product or service is delivered to the acquirer from the supplier according to the supplier agreement.

A supplier agreement created using these practices enables the acquirer to monitor and control supplier activities using other process areas, such as **Project Monitoring and Control** and **Agreement Management**.

The practices of this process area apply equally to initial supplier agreements and to subsequent change orders, task orders, or amendments related to those agreements.

The acquirer is responsible for establishing and maintaining ground rules for communicating with the supplier, documenting decisions, and resolving conflict through the life of the agreement. The acquirer facilitates these activities with relevant stakeholders. Roles and responsibilities of relevant stakeholders during the interaction with suppliers are defined, coordinated, and adhered to.

The specific goals and specific practices of this process area build on each other. The Prepare for Solicitation and Supplier Agreement Development specific goal and its associated specific practices identify potential suppliers and develop and distribute the solicitation package, including evaluation criteria and the statement of work. The solicitation package is developed using work products from other process areas (e.g., requirements and design constraints from Acquisition Requirements Development, supplier project and technical measures and objectives from Project Planning and Measurement and Analysis).

The Select Suppliers specific goal and its associated specific practices use work products from the preparation of the solicitation to solicit responses from potential suppliers, evaluate these responses, negotiate with potential suppliers, and select a supplier who can best deliver. Subsequently, the Establish Supplier Agreements specific goal and its associated specific practices are used to establish and maintain the supplier agreement. In turn, data provided by the supplier and documented in the supplier agreement (e.g., cost, schedule, risks) are used by Project Planning practices to update the project plan.

This process area contains many lists of examples to include in work products. As in other process areas, these lists are not all-inclusive and the acquirer should rely on other related lists when building work products. Considerations for supplier agreement content are described throughout the process areas.

Although this process area describes acquisition practices for a project, an acquirer would use the same practices in establishing a supplier agreement for multiple projects. The requirements included in the solicitation package and the supplier agreement would reflect a broader scope, and the evaluation and selection process would require an appropriate level of review before a selection is made.

Related Process Areas

Refer to the Project Planning process area for more information about planning for solicitation, developing and documenting the project plan for the acquisition, estimating the supplier's work, and revising the project plan.

Refer to the Measurement and Analysis process area for more information about specifying project measurement data.

Refer to the Acquisition Requirements Development process area for more information about defining customer and contractual requirements.

Refer to the Requirements Management process area for more information about managing requirements, including changes to requirements and traceability of requirements for products acquired from suppliers.

Refer to the Agreement Management process area for more information about monitoring and analyzing selected supplier activities and processes based on the supplier agreement.

Refer to the Decision Analysis and Resolution process area for more information about formal evaluation methods that can be used to select suppliers.

Specific Goal and Practice Summary

SG 1 Prepare for Solicitation and Supplier Agreement Development

- SP 1.1 Identify Potential Suppliers
- SP 1.2 Establish a Solicitation Package
- SP 1.3 Review the Solicitation Package
- SP 1.4 Distribute and Maintain the Solicitation Package

SG 2 Select Suppliers

- SP 2.1 Evaluate Proposed Solutions
- SP 2.2 Establish Negotiation Plans
- SP 2.3 Select Suppliers

SG 3 Establish Supplier Agreements

- SP 3.1 Establish an Understanding of the Agreement
- SP 3.2 Establish the Supplier Agreement

Specific Practices by Goal

SG 1 Prepare for Solicitation and Supplier Agreement Development

Preparation for solicitation and supplier agreement development is performed.

SP 1.1 Identify Potential Suppliers

Identify and qualify potential suppliers.

Consistent with internal organizational policy, the acquisition strategy, and project scope and requirements, the acquirer identifies potential suppliers to receive the solicitation. The acquirer can identify suppliers from a variety of sources (e.g., employees, international seminars, market analysis reports, pre-established schedules).

In some organizations, acquirers may solicit proposals from a limited number of suppliers in order to reduce their cost and efforts for the solicitation. Acquirers must, however, ensure that they include suppliers who are capable of meeting the requirements and that a sufficient number of suppliers are included to provide a competitive environment. This competition enhances the leverage of the acquirer in achieving its objectives (e.g., providing different approaches to meeting requirements).

Depending on applicable regulations and project characteristics, the acquirer may determine to pursue a sole-source acquisition rather than a competitive bid. Acquirers should document the rationale for determining potential suppliers, particularly in the case of sole-source selection.

Typical Work Products

1. List of potential suppliers prepared to respond to the solicitation

Subpractices

1. Develop a list of potential suppliers.

To develop a list of potential suppliers, the acquirer considers which suppliers have experience with similar systems or projects, the performance the acquirer has experienced with suppliers on previous projects, which suppliers are likely to provide the capabilities needed for the project, and the availability of critical resources to staff and support the project. In addition to assessing supplier capabilities, a risk assessment is prepared on the suppliers' financial capabilities (e.g., credit worthiness, financial stability and access to capital and the impact to the supplier of a successful bid).

2. Communicate with potential suppliers concerning the forthcoming solicitation.

The acquirer contacts suppliers to outline plans for the solicitation, including the projected schedule for releasing the solicitation package and expected dates for responses from suppliers. If a supplier expresses interest in responding to the solicitation, the appropriate confidentiality agreements are put in place.

Typical communication to candidate suppliers includes the following:

- Anticipated scope of the solicitation
- Schedule for release of the solicitation package
- Overall project schedule
- Approach and procedures to be used throughout the solicitation process
- High-level criteria for evaluating proposal responses
- Required supplier qualifications
- Schedule for the return of proposals
- Date when the supplier must indicate if it will or will not participate in the solicitation

3. Verify participants who will evaluate supplier proposals.
4. Verify participants in supplier negotiations.

SP 1.2 Establish a Solicitation Package

Establish and maintain a solicitation package that includes the requirements and proposal evaluation criteria.

Solicitation packages are used to seek proposals from potential suppliers. The acquirer structures the solicitation package to facilitate an accurate and complete response from each potential supplier and to enable an effective comparison and evaluation of proposals.

The solicitation package includes a description of the desired form of the response, the relevant statement of work for the supplier, and required provisions in the supplier agreement (e.g., a copy of the standard supplier agreement or non-disclosure provisions). In government acquisitions, some or all of the content and structure of the solicitation package may be defined by regulation.

The solicitation package typically contains the following:

- The statement of work for the supplier, including supplier process, product, and service level measures
- Guidance on how potential suppliers are to respond to the solicitation package
- A description and criteria to be used to evaluate proposals
- Documentation requirements to submit with the response (e.g., project plans)
- The schedule for completing the solicitation process
- Procedures for addressing questions and contacts

The solicitation package is rigorous enough to ensure consistent and comparable responses but flexible enough to allow consideration of supplier suggestions for better ways to satisfy requirements. The acquirer can invite suppliers to submit a proposal that is wholly responsive to the request for proposal and to provide a proposed alternative solution in a separate proposal.

The complexity and level of detail of the solicitation package should be consistent with the value of, and risk associated with, the planned acquisition. In some cases, the solicitation may not include detailed requirements (e.g., it may be a solicitation for development of detailed requirements or it may include a statement of objectives to provide the supplier greater flexibility in addressing the scope of the project).

Proposal and supplier evaluation criteria are identified and documented.

Typical Work Products

1. Solicitation package
2. Supplier and proposal evaluation criteria

Subpractices

1. Develop the statement of work for the supplier.

The statement of work for the supplier defines, for those items being acquired, the portion of the project scope that is included in the related supplier agreement. The statement of work for a supplier is developed from the project scope, the work breakdown structure, and the task dictionary.

The statement of work for the supplier is written to be clear, complete, and concise. It describes the acquired product or service in sufficient detail to allow prospective suppliers to determine if they are capable of providing the product or service.

Example content of the statement of work for the supplier includes the following:

- Project objectives
- Requirements (including period of performance; milestones; work location; legal, statutory, and regulatory requirements; delivery format; quantities; and content requirements)
- Design constraints
- Deliverables and rights (e.g., work breakdown structure of the supplier's work, detailed design, and test results)
- An overview of the project with sufficient information for the supplier to understand the project environment and risks
- Expectations of the supplier's transition of the product to operations and support
- Expectations for process, product, and service level measures and reports that provide the acquirer visibility into supplier progress and performance
- Collateral services required (e.g. study reports, development of training materials, delivery of training to end users)
- Acquirer specified standard processes for the project (e.g., configuration management, issue escalation and resolution, corrective action for nonconformances, and change management)
- The type of reviews to be conducted with the supplier and other communication processes and procedures
- Product acceptance criteria and required supplier involvement in the acquirers validation and acceptance activities
- Post-project support

The statement of work for the supplier can be revised and refined as it moves through the solicitation, negotiation, and supplier agreement development processes until it is incorporated into a signed supplier agreement. For example, a prospective supplier can suggest a more efficient approach or a less costly product than those originally specified.

2. Specify the process, product, and service level measures for acceptance.

The measures specify customer expectations and threshold values and are used to monitor the supplier and gauge the supplier's adherence to requirements.

Service levels are an indicator of performance relative to an agreed-on service level measure. Service levels are designed to support the acquisition strategy. (See the definitions of "service level" and "measure" in the glossary.)

3. Develop supplier evaluation and proposal evaluation criteria.

Evaluation criteria are developed and used to rate or score proposals. Evaluation criteria are included in the solicitation package. Evaluation criteria can be limited to purchase price if the acquisition item is readily available from a number of acceptable suppliers. Purchase price in this context includes both the cost of the item and ancillary expenses such as delivery. Other selection criteria can be identified and documented to support an evaluation of a more complex product or service (e.g., the individuals identified in the Project Planning resource plan develop and document criteria for evaluating potential suppliers and their proposals).

Examples of areas used to evaluate a potential supplier's ability and proposal include the following:

- Compliance to stated requirements contained in the solicitation package
- Experience with similar products or services (e.g., data on most recent similar projects with the associated cost, schedule, and quality performance and the degree to which requirements were fulfilled)
- Familiarity with acquirer processes, the technical environment, and the core business
- Total ownership and lifecycle costs
- Technical capability (e.g., expected functional and performance compliance to requirements and criteria given the architecture and technical solution proposed)
- Management, development, and delivery processes and procedures
- Proposed technical methodologies, techniques, solutions, and services
- Financial capability
- Production capacity and interest (e.g., staff available to perform the effort, available facilities, and other available resources)
- Business size and type
- Intellectual property and proprietary rights

4. Document the proposal content that suppliers must submit with their response.

Examples of proposal content required for suppliers to submit include the following:

- Compliance with requirements
- References, company overview, and case studies
- Evidence of the supplier's organizational processes on which supplier processes for the project will be based and the commitment to execute those processes from project inception
- Plan describing how the supplier will carry out the scope and content of the solicitation package, including any improvements of execution capability over the duration of the supplier agreement
- Understanding of the size and complexity of the requested work based on requirements
- The pricing and compensation methodology that enables calculation of charges for the services being provided to the acquirer pursuant to supplier agreement terms and conditions, including taxes, credits, foreign currency translation, licenses, pass-through costs, and travel reimbursements
- Pricing and compensation schedules that provide for charges for the products and services provided, including frequency, term, and pricing type (e.g., fixed price, lump sum, time and materials) as well as rate cards, and a skills matrix
- Compliance with acquirer travel reimbursement policies
- References and experience validating the capability of the supplier's proposed approach to meet proposed funding, schedule, and quality targets
- Risk management plan describing how the supplier will periodically manage risks throughout the life of the project and how risks documented in the solicitation package will be managed
- Methods for early defect identification and the prevention of defects in delivered products
- The supplier's approach to assuring the quality of the product
- Approach to the escalation and resolution of issues
- Description of the supplier's proposed use of COTS and rationale for the supplier's confidence that COTS can achieve the requirements
- Description of the supplier's proposed reuse of previously developed hardware and software, rationale for the supplier's confidence that re-use can be achieved, and associated information about data rights
- Approach to providing visibility of development progress and costs at a level appropriate for the type of agreement and commensurate with the degree of risk
- Retention of critical staff during the project
- Identification of work to be performed by subcontractors

5. Incorporate the acquirer's (standard) supplier agreement, terms and conditions, and additional information into the solicitation package.

Supplier agreement terms and conditions typically include the following:

- Recitals
- Deliverables and rights
- Compensation and payments
- Confidentiality
- Privacy statements
- Continuous improvement and best practices
- Exclusive services, key employees, supplier personnel at acquirer sites
- Information gathering practices and ethical representation
- Force majeure
- Term
- Termination for insolvency, breach, or non-performance
- Termination for convenience
- Termination assistance
- Indemnification
- Insurance
- Right to audit
- Notices

Typical considerations for additional instructions and general information to help the supplier when responding to the solicitation package include the following:

- Submission of intent to submit proposal
- Submission due date, time, and destination
- Number of proposal copies that must be submitted
- Proposal format
- Non-complying proposals
- Proposal ownership
- Bidder inquiries
- Key dates and activities
- Discretionary selection and potential modifications of the solicitation process
- No implied offer
- Response constitutes an offer to do business
- Confidentiality of information
- Publicity
- Use of subcontractors
- Due diligence
- Incurred costs
- Language requirements
- Statutory units
- Warranty provisions
- Licensing provisions

SP 1.3 Review the Solicitation Package

Review the solicitation package with stakeholders to ensure that the approach is realistic and can reasonably lead to the acquisition of a usable product.

The solicitation package is reviewed with stakeholders to ensure requirements have been accurately and sufficiently stated so that the solicitation can lead to a manageable agreement. The acquirer establishes traceability between requirements and the solicitation package. Suppliers may be included as stakeholders in the review of the solicitation package. The acquirer wants the solicitation package to attract a variety of responses and encourage competition. The acquirer also wants the solicitation package to be legally inclusive of all qualified suppliers.

Refer to the Perform Peer Reviews specific goal of the Acquisition Verification process area for more information about conducting peer reviews.

The acquirer may use standard templates and checklists to verify that the necessary components (e.g., skills, standards, verification and validation methods, measures, and acceptance criteria) are covered in the solicitation package.

Refer to the Organizational Process Definition process area for more information about standard checklists and templates in the organizational process assets.

The independent cost and schedule estimates for the supplier's project work are reviewed.

Typical Work Products

1. Record of the reviews of the solicitation package

SP 1.4 Distribute and Maintain the Solicitation Package

Distribute the solicitation package to potential suppliers for their response and maintain the package throughout the solicitation.

The solicitation package is distributed to potential suppliers in accordance with approved acquirer solicitation policies and procedures.

Refer to the Project Planning process area for more information about planning solicitation activities as necessary.

Refer to the Project Monitoring and Control process area for more information about monitoring and controlling solicitation activities as necessary.

Typical Work Products

1. Responses to supplier questions
2. Amendments to the solicitation package

Typical Supplier Deliverables

1. Supplier proposals
2. Supplier questions and requests for clarification

Subpractices

1. Finalize a list of potential suppliers.
2. Distribute the solicitation package to potential suppliers.

3. Document and respond to supplier questions according to the instructions in the solicitation package.

Verify that all potential suppliers have equal access and opportunity to provide feedback on the solicitation package. Provide the opportunity for selected potential suppliers and stakeholders to clarify points of ambiguity in requirements as well as disconnects or concerns with requirements.
4. Acknowledge the receipt of supplier proposals according to the schedule identified in the solicitation package.
5. Verify conformance to requirements and completeness of supplier responses.

Contact suppliers if the response is non-conforming or incomplete for corrective action.
6. Issue amendments to the solicitation package when changes are made to the solicitation.

SG 2 Select Suppliers

Suppliers are selected using a formal evaluation.

Suppliers are selected according to approved acquirer selection policies and procedures.

Refer to the Decision Analysis and Resolution process area for more information about formal evaluation approaches that can be used to select suppliers.

SP 2.1 Evaluate Proposed Solutions

Evaluate proposed solutions according to documented proposal evaluation criteria.

Proposals submitted in response to solicitation packages are evaluated in accordance with an overall established timeline, preliminary project plans, and proposal evaluation criteria. Proposal evaluation criteria are used to evaluate potential supplier responses to the solicitation. Evaluation results and decision-making notes (e.g., advantages and disadvantages of potential suppliers and scoring against criteria) should be documented and maintained.

For task orders or changes in the terms of an existing supplier agreement, the acquirer uses documented evaluation criteria to evaluate task order responses or proposed changes to terms of the agreement. In a sole-source or change order environment, this practice is critical to enable relevant stakeholder understanding of the intent of the effort or changes before placing additional work against the supplier agreement.

Typical Work Products

1. Clarification correspondence between the acquirer and potential suppliers
2. Evaluation results and rationale
3. List of candidate suppliers

Typical Supplier Deliverables

1. Proposal revisions based on clarifications
2. Supplier documentation of their approach to the project work, their capabilities, and a preliminary technical solution

Subpractices

1. Distribute supplier proposals to individuals identified by the acquirer to perform the evaluation.
2. Schedule an acquirer evaluation review of supplier proposals to consolidate questions, concerns, and issues.
3. Schedule supplier presentations.
4. Confirm the mutual understanding of the statement of work.

A good practice is to compare the supplier's estimates to those developed in project planning; this comparison provides a means to determine if there is a mutual understanding of requirements and the associated work to fulfill them.

5. Evaluate supplier proposals and document findings.
6. Execute due diligence.

Due diligence provides an opportunity for the acquirer to further clarify requirements, particularly those related to the acquirer's existing environment and products in use. Potential suppliers ask questions and gain understanding, which enables them to make realistic proposals. It also enables the acquirer to gain insight into the capability of the potential suppliers' proposed solutions to meet requirements.

Due diligence helps to eliminate assumptions and replace them with facts, to identify and document risks and their mitigation plans or effect on the agreement, and to list issues and dependencies between the acquirer and supplier to include in the agreement.

Examples of typical due diligence activities include the following:

- Reviews of requirements with the current supplier or acquirer resources maintaining the products or providing the services
- Reviews of interfaces of a system with other systems maintained by the acquirer
- Reviews and validations of supplier references
- Reviews of the operating environment's facilities and capabilities
- Reviews of regulatory and security requirements
- Reviews of supplier capabilities

7. Document candidate supplier recommendations based on the proposal evaluation.

SP 2.2 Establish Negotiation Plans

Establish and maintain negotiation plans to use in completing a supplier agreement.

The acquirer develops and refines a negotiation plan for each of the candidate suppliers based on the evaluation of the suppliers and their proposals.

The proposal evaluation and negotiations with suppliers provide the basis for selecting the supplier best able to meet the requirements of the solicitation.

The size of a negotiation team depends on the size and complexity of the project. Typically, the team is led by acquirer management and includes individuals who have detailed knowledge of the statement of work documented in the solicitation package. The negotiation team is typically supported by legal staff, a financial analyst, purchasing, and the project manager.

Negotiations between acquirers and suppliers may be restricted by regulation. Review all regulations affecting negotiations before entering into them with a supplier.

Examples of items included in a negotiation plan include the following:

- Roles and responsibilities of negotiation team members
- Key issues to be negotiated from supplier responses
- Negotiation “levers” and where and when they should be used
- The sequence of events to negotiate issues
- Fall-back or compromise positions as necessary on given issues (possible concessions and trades)
- List of items that are non-negotiable
- External factors that could influence negotiations; (e.g., other pending deals and strategic plans)
- Prior experiences with supplier agreements to discover previous positions and issues (and negotiating styles)
- Schedule and sequence of supplier negotiation meetings
- Objectives for each negotiating session
- Risks, consequences, and mitigation alternatives

Typical Work Products

1. Negotiation plan for each candidate supplier

SP 2.3 Select Suppliers

Select suppliers based on an evaluation of their ability to meet specified requirements and established criteria.

Proposal evaluation results are used to finalize a supplier selection based on the outcome of negotiations or responses to acquirer questions provided by potential suppliers. Negotiations enable the acquirer to select the best supplier for the project. In some cases, the acquirer may take the top two proposals and use negotiations to make the final selection decision.

Evaluation results and negotiation results support the selection decision or cause the acquirer to take other action, as appropriate. If the return on investment is not sufficient, the acquirer may decide to defer or cancel the project.

Typical Work Products

1. Revisions due to negotiations
2. Supplier selection decision
3. Evaluation reports

Subpractices

1. Evaluate supplier proposals.
2. Negotiate with suppliers to determine the best fit for the project.

Negotiate with the selected supplier or candidate suppliers to resolve issues identified during due diligence and to address remaining issues with requirements. Revise requirements to be fulfilled by the supplier as appropriate.

3. Select a supplier to be awarded the supplier agreement.

Refer to the Decision Analysis and Resolution process area for more information about formal evaluation methods that can be used to select suppliers.

4. Document the selection.

SG 3 Establish Supplier Agreements

Supplier agreements are established and maintained.

A supplier agreement is established and maintained based on the supplier selection decision.

SP 3.1 Establish an Understanding of the Agreement

Establish and maintain a mutual understanding of the agreement with selected suppliers and end users based on acquisition needs and the suppliers' proposed approaches.

Points of clarification and ambiguities may arise after award of the supplier agreement; therefore, the acquirer should work with the supplier to ensure that a mutual understanding is maintained through the life of the project (e.g., supplier workshops and executive meetings).

Typical Work Products

1. Correspondence clarifying elements of the agreement
2. Frequently asked questions (for use with end users and other suppliers)

SP 3.2 Establish the Supplier Agreement

Establish and maintain the supplier agreement

The agreement may be either a stand-alone agreement or part of a master agreement. When part of a master agreement, the project agreement may be an addendum, work order, or service request to the master agreement.

Typical Work Products

1. Supplier agreement (including terms and conditions)

Subpractices

1. Establish the supplier agreement.

Supplier agreement provisions typically include the following:

- The statement of work, specification, terms and conditions, list of deliverables, schedule, budget, and acceptance process
- Product acceptance criteria to be satisfied by the supplier
- Mechanisms and deliverables that provide sufficient data to allow the acquirer to evaluate and analyze acquired products
- Which acquirer and supplier representatives are responsible and authorized to make changes to the supplier agreement
- How requirements changes and changes to the supplier agreement are determined, communicated, and addressed
- Standards and procedures to be followed (e.g., configuration management, escalation, nonconformances, conflicts, and issues)
- Requirements for the supplier to establish a corrective action system that includes a change control process for rework and reevaluation
- Critical dependencies between the acquirer and supplier
- Documentation of what the acquirer will provide to the supplier (e.g., facilities, tools, software, documentation, and services)
- Analysis methods and acceptance criteria for designated supplier deliverables
- The types of reviews to be conducted with the supplier
- The supplier's responsibilities to execute corrective actions when initiated by project monitoring and control processes
- Non-hire and non-compete clauses
- Confidentiality, non-disclosure, and intellectual capital clauses pertaining to process and product quality assurance, measurement data, and personnel who would perform audits or are authorized to validate measurement data
- The supplier's responsibilities for preparing the site and training the support and operations organizations according to acquirer specified standards, tools, and methods
- The supplier's responsibilities for ongoing maintenance and support of acquired products and their role as a stakeholder
- Requirements for the supplier to maintain bi-directional traceability to requirements provided in the supplier agreement
- Requirements for the supplier to be involved in deployment as necessary
- Warranty, ownership, usage, and data rights for acquired products
- Schedule for supplier compensation
- Security and legal penalty recoveries
- Dispute resolution procedures

2. Verify that all parties to the agreement understand and agree to all requirements by signing the supplier agreement.

The acquirer should ensure that the supplier makes a commitment in the agreement to execute its proposed processes.

3. Notify those suppliers not selected for the award.
4. Communicate the supplier agreement in the organization as required.
5. Maintain the supplier agreement as required.

After establishment of the supplier agreement, the acquirer may find requirements that are no longer optimal or applicable based on the supplier's progress or environment changes. Examples include the availability of new technology, overly burdensome documentation, and reporting requirements. Changes to supplier agreements may also occur when the supplier's processes or products fail to meet agreed-to criteria.

Revise the supplier agreement and internal project documents to reflect changes in conditions as appropriate. Update cost, schedule, and budget documents as needed.

All changes are formally documented and approved by both the acquirer and supplier before being implemented by this specific practice. Approved change requests can include modifications to terms and conditions of the supplier agreement, including the statement of work, pricing, and the descriptions of products, services, or results to be acquired.

Refer to the Configuration Management process area for more information about tracking and controlling changes.

6. Ensure that all records related to the supplier agreement are stored, managed, and controlled for future use.

PART THREE

The Appendices and Glossary

Appendix A: References

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Appendix B: Acronyms

ACQ	Acquisition constellation
AM	Agreement Management (process area)
ARC	Appraisal Requirements for CMMI
ARD	Acquisition Requirements Development (process area)
ATM	Acquisition Technical Management (process area)
AVAL	Acquisition Validation (process area)
AVER	Acquisition Verification (process area)
CAR	Causal Analysis and Resolution (process area)
CCB	configuration control board
CL	capability level
CM	Configuration Management (process area)
CMM	Capability Maturity Model
CMMI	Capability Maturity Model Integration
CMMI-ACQ	CMMI for Acquisition
CMMI-DEV	CMMI for Development
COTS	commercial off the shelf
CPI	cost performance index
CPM	critical path method
DAR	Decision Analysis and Resolution (process area)
DEV	Development constellation
DoD	Department of Defense

EDS	Electronic Data Systems
EIA	Electronic Industries Alliance
EIA/IS	Electronic Industries Alliance/Interim Standard
GG	generic goal
GP	generic practice
GM	General Motors
IBM	International Business Machines
IDEAL	Initiating, Diagnosing, Establishing, Acting, Learning
IEEE	Institute of Electrical and Electronics Engineers
IPD-CMM	Integrated Product Development Capability Maturity Model
IPM	Integrated Project Management (process area)
ISO	International Organization for Standardization
ISO/IEC	International Organization for Standardization and International Electrotechnical Commission
IT	Information Technology
MA	Measurement and Analysis (process area)
MDD	Method Definition Document
ML	maturity level
NDIA	National Defense Industrial Association
OID	Organizational Innovation and Deployment (process area)
OPD	Organizational Process Definition (process area)
OPF	Organizational Process Focus (process area)
OPP	Organizational Process Performance (process area)
OT	Organizational Training (process area)
OUSD (AT&L)	Office of the Under Secretary of Defense (Acquisition, Technology, and Logistics)

P-CMM	People Capability Maturity Model
PA	process area
PERT	Program Evaluation and Review Technique
PMC	Project Monitoring and Control (process area)
PP	Project Planning (process area)
PPQA	Process and Product Quality Assurance (process area)
QA	quality assurance
QFD	Quality Function Deployment
QPM	Quantitative Project Management (process area)
REQM	Requirements Management (process area)
RSKM	Risk Management (process area)
SA-CMM	Software Acquisition Capability Maturity Model
SCAMPI	Standard CMMI Appraisal Method for Process Improvement
SECM	Systems Engineering Capability Model
SEI	Software Engineering Institute
SG	specific goal
SP	specific practice
SPI	schedule performance index
SSAD	Solicitation and Supplier Agreement Development (process area)
SW-CMM	Capability Maturity Model for Software or Software Capability Maturity Model
WBS	work breakdown structure

Appendix C: Project Participants

Many talented people were part of the product team that developed CMMI-ACQ. Listed below are those who participated in one or more of the following teams during the development of CMMI-ACQ. The organizations listed by members' names are those they represented at the time of their team membership.

There were seven primary groups involved in the development of this model:

- the initial draft development team
- the CMMI Architecture Team
- the CMMI-ACQ, V1.2 Model Team
- the CMMI-ACQ, V1.2 Training Team
- the CMMI-ACQ, V1.2 Quality Team
- the CMMI Acquisition Advisory Board
- the CMMI Steering Group

Initial Draft Development Team

The initial draft development team created the document used as the initial baseline for the development of CMMI-ACQ, Version 1.2. This document was piloted by a few select organizations and publicly reviewed.

- Kathryn M. Dodson, EDS
- Matt Fisher, Software Engineering Institute
- Hubert F. Hofmann, General Motors
- Keith Kost, Software Engineering Institute
- Gowri S. Ramani, Hewlett Packard
- Deborah K. Yedlin, General Motors

CMMI Architecture Team

In 2005 and 2006, the CMMI Architecture Team updated the architecture used to build components of the CMMI Product Suite, such as models and training materials.

- Roger Bate, Software Engineering Institute
- Mary Beth Chrissis, Software Engineering Institute
- Hubert F. Hofmann, General Motors
- Craig Hollenbach, Northrop Grumman
- Lisa Ming, BAE Systems
- Mike Phillips, Software Engineering Institute
- John Scibilia, U.S. Army
- Hal Wilson, Northrop Grumman
- Gary Wolf, Raytheon

CMMI-ACQ, V1.2 Model Team

The Version 1.2 CMMI-ACQ Model Team used the baseline developed by the initial draft development team and input from reviewers and users to revise the initial draft and create CMMI-ACQ, Version 1.2.

- Lloyd Anderson, Department of Homeland Security
- Larry Baker, Defense Acquisition University
- Roger Bate, Software Engineering Institute
- Rhonda Brown, Software Engineering Institute
- Aaron Clouse, Software Engineering Institute
- Brad Doohan, Defence Materiel Organisation
- Tom Keuten, General Motors
- Mike Konrad, Software Engineering Institute
- Keith Kost, Software Engineering Institute
- Madhav S. Panwar, U.S. Government Accountability Office
- Mike Phillips, Software Engineering Institute
- Margaret Porteus, Institute for Defense Analyses
- George Prosnik, Defense Acquisition University
- Karen Richter, Institute for Defense Analyses
- John Scibilia, U.S. Army
- Sandy Shrum, Software Engineering Institute
- Deborah K. Yedlin, Borland Software Corporation

CMMI-ACQ, V1.2 Training Team

The Version 1.2 CMMI-ACQ Training Team included a core team of developers and many reviewers. The development team used baselines created by the CMMI-ACQ, V1.2 Model Team and the existing *Introduction to CMMI* course to develop training for CMMI-ACQ, V1.2.

- Bruce Allgood, U.S. Air Force
- Rhonda Brown, Software Engineering Institute
- Peter Capell, Software Engineering Institute
- Mary Beth Chrissis, Software Engineering Institute
- Aaron Clouse, Software Engineering Institute
- Erin Czerwinski, Software Engineering Institute
- Jack Ferguson, Software Engineering Institute
- Matt Fisher, Software Engineering Institute
- Thierry Girou, Thales
- Jon Gross, Software Engineering Institute
- Tom Keuten, General Motors
- Mike Konrad, Software Engineering Institute
- Phil Miller, Software Engineering Institute
- Mike Phillips, Software Engineering Institute
- Christine Safa, Thales
- Sandy Shrum, Software Engineering Institute
- Barbara Tyson, Software Engineering Institute
- Christian Zion, Thales

CMMI-ACQ, V1.2 Quality Team

The Version 1.2 CMMI-ACQ Quality Team used a process developed over the years for CMMI model quality assurance. The team tailored the quality assurance (QA) process to CMMI-ACQ, V1.2 to prepare it and the training material developed by the CMMI-ACQ, V1.2 Training Team for release.

- Rhonda Brown, Software Engineering Institute
- Pamela Curtis, Software Engineering Institute
- Keith Kost, Software Engineering Institute
- Sandy Shrum, Software Engineering Institute

CMMI Acquisition Advisory Board

The CMMI Acquisition Advisory Board was responsible for providing direction to and approving the development work of the CMMI-ACQ, Version 1.2 Model Team. The board had final authority regarding decisions that impacted CMMI-ACQ, Version 1.2.

- Kristen Baldwin, OUSD (AT&L) SSE/SSA
- Tony D'Agosto, U.S. Army
- Richard Frost, General Motors
- Hubert F. Hofmann, General Motors
- Guy Mercurio, Defense Contract Management Agency
- Lawrence Osiecki, U.S. Army
- Madhav Panwar, U.S. Government Accountability Office
- Bob Rassa, National Defense Industry Association
- Linda Roush, U.S. Navy
- Katie Smith, U.S. Navy
- Michael W. Smith, Missile Defense Agency
- Bob Swartz, U.S. Air Force (the MITRE Corporation)

CMMI Steering Group

The CMMI Steering Group has guided and approved the plans of the version 1.2 CMMI Product Team, provided consultation on significant CMMI project issues, ensured involvement from a variety of interested communities, and approved the final release of this model.

Steering Group Members

- Kristen Baldwin, OUSD (AT&L) SSE/SSA
- Clyde Chittister, Software Engineering Institute
- Jim Gill, Boeing Integrated Defense Systems
- John Kelly, NASA HQ
- Kathy Lundein, Defense Contract Management Agency
- Larry McCarthy, Motorola, Inc.
- Mike Nicol, U.S. Air Force ASC/EN
- Lawrence Osiecki (U.S. Army)
- Bill Peterson, Software Engineering Institute
- Bob Rassa, Raytheon Space & Airborne Systems

- Joan Weszka, Lockheed Martin
- Hal Wilson, Northrop Grumman Mission Systems
- Brenda Zettervall, U.S. Navy, ASN/RDA CHENG

Ex-Officio Steering Group Members

- Lloyd Anderson, Department of Homeland Security
- Roger Bate, chief architect, Software Engineering Institute
- Mike Phillips, CMMI program manager, Software Engineering Institute
- Beth Sumpter, National Security Agency

Steering Group Support: Acquisition

- Brian Gallagher, Software Engineering Institute

Steering Group Support: CCB

- Mike Konrad, Software Engineering Institute

During the development of CMMI-ACQ, there were others who served temporarily on the CMMI Steering Group. Anthony D'Agosto (U.S. Army RDECOM ARDEC) was a full Steering Group member. Thomas Drake (SES) and Deborah K. Yedlin (General Motors) were ex-officio members.

Appendix D: Glossary

The glossary defines the basic terms used in CMMI models. Glossary entries are typically multiple-word terms consisting of a noun and one or more restrictive modifiers. (There are some exceptions to this rule that account for one-word terms in the glossary.)

To formulate definitions appropriate for CMMI, we consulted multiple sources. We first consulted the *Merriam-Webster OnLine* dictionary (<http://www.m-w.com>) and the source models (i.e., CMMI v1.2, EIA 731, SW-CMM v2, draft C, and IPD-CMM v0.98). We also consulted other standards as needed, including the following:

- ISO 9000 [ISO 2000]
- ISO/IEC 12207 [ISO 1995]
- ISO/IEC 15504 [ISO 2006]
- ISO/IEC 15288 [ISO 2002a]
- ISO/IEC 15939 [ISO 2002b]
- ISO 20000-1 [ISO 2005]
- IEEE [IEEE 1991]
- CobiT v. 4.0 [IT Governance 2005]
- SW-CMM v1.1
- EIA 632 [EIA 2003]
- SA-CMM [SEI 2002]
- P-CMM [Curtis 2001]

We developed the glossary recognizing the importance of using terminology that all model users can understand. We also recognized that words and terms can have different meanings in different contexts and environments. The glossary in CMMI models is designed to document the meanings of words and terms that should have the widest use and understanding by users of CMMI products.

Because CMMI for Acquisition was designed to apply to acquisition environments for both products and services, many of the terms in the glossary include both products and services in their definitions.

acceptance criteria	The criteria that a deliverable must satisfy to be accepted by a user, customer, or other authorized entity. (See also “deliverable.”)
acceptance testing	Formal testing conducted to enable a user, customer, or other authorized entity to determine whether to accept a deliverable. (See also “unit testing.”)
achievement profile	In the continuous representation, a list of process areas and their corresponding capability levels that represent the organization’s progress for each process area while advancing through the capability levels. (See also “capability level profile,” “target profile,” and “target staging.”)
acquirer	The stakeholder that acquires or procures a product or service from a supplier. (See also “stakeholder.”)
acquisition	The process of obtaining products or services through supplier agreements. (See also “supplier agreement.”)
acquisition strategy	The specific approach to acquiring products and services that is based on considerations of supply sources, acquisition methods, requirements specification types, contract or agreement types, and related acquisition risks.
adequate	Interpret goals and practices in light of the organization’s business objectives. When using any CMMI model, practices should be interpreted in a way that works for the organization. This term is used in goals and practices in which certain activities may not be equally relevant in all situations. (See also “appropriate” and “as needed.”)
allocated requirement	Requirement that levies all or part of the performance and functionality of a higher level requirement on a lower level architectural element or design component.
alternative practice	A practice that is a substitute for one or more generic or specific practices contained in CMMI models that achieves an equivalent effect toward satisfying the generic or specific goal associated with it. Alternative practices are not necessarily one-for-one replacements for generic or specific practices.
amplifications	Amplifications are informative model components that contain information relevant to a particular discipline. For example, to find amplifications for software engineering, look in the model for items labeled “For Software Engineering.” The same is true for amplifications for other disciplines.

appraisal	In the CMMI Product Suite, an examination of one or more processes by a trained team of professionals using an appraisal reference model as the basis for determining, at a minimum, strengths and weaknesses. (See also “assessment.”)
appraisal findings	The results of an appraisal that identify the most important issues, problems, or opportunities for process improvement within the appraisal scope. Appraisal findings are inferences drawn from corroborated objective evidence.
appraisal participants	Members of the organizational unit who participate in providing information during an appraisal.
appraisal rating	As used in CMMI appraisal materials, the value assigned by an appraisal team to (a) a CMMI goal or process area, (b) the capability level of a process area, or (c) the maturity level of an organizational unit. A rating is determined by enacting the defined rating process for the appraisal method being employed.
appraisal reference model	As used in CMMI appraisal materials, the CMMI model to which an appraisal team correlates implemented process activities.
appraisal scope	The definition of the boundaries of an appraisal encompassing the organizational limits and CMMI model limits within which the processes to be investigated operate.
appraisal team leader	A person who leads the activities of an appraisal and has satisfied qualification criteria for experience, knowledge, and skills defined by the appraisal method.
appropriate	Interpret goals and practices in light of the organization’s business objectives. When using any CMMI model, practices should be interpreted in a way that works for the organization. This term is used in goals and practices in which certain activities may not be equally relevant in all situations. (See also “adequate” and “as needed.”)
as needed	Interpret goals and practices in light of the organization’s business objectives. When using any CMMI model, practices should be interpreted in a way that works for the organization. This term is used in goals and practices in which certain activities may not be equally relevant in all situations. (See also “adequate” and “appropriate.”)

assessment	In the CMMI Product Suite, an appraisal that an organization does internally for the purposes of process improvement. The word assessment is also used in the CMMI Product Suite in an everyday English sense (e.g., risk assessment). (See also “appraisal.”)
assignable cause of process variation	In CMMI, the term “special cause of process variation” is used in place of “assignable cause of process variation” to ensure consistency. The two terms are defined identically. (See “special cause of process variation.”)
audit	In CMMI process improvement work, an objective examination of a work product or set of work products against specific criteria (e.g., requirements).
base measure	A distinct property or characteristic of an entity and the method for quantifying it. (See also “derived measures.”)
baseline	A set of specifications or work products that has been formally reviewed and agreed on, which thereafter serves as the basis for further development, and which can be changed only through change control procedures. (See also “configuration baseline” and “product baseline.”)
bidirectional traceability	An association among two or more logical entities that is discernable in either direction (i.e., to and from an entity). (See also “requirements traceability” and “traceability.”)
business objectives	(See “organization’s business objectives.”)
capability level	Achievement of process improvement within an individual process area. A capability level is defined by appropriate specific and generic practices for a process area. (See also “generic goal,” “generic practice,” “maturity level,” and “process area.”)
capability level profile	In the continuous representation, a list of process areas and their corresponding capability levels. (See also “achievement profile,” “target profile,” and “target staging.”)
	A capability level profile may be an achievement profile when it represents the organization’s progress for each process area while advancing through the capability levels. Or, it may be a target profile when it represents an objective for process improvement.

capability maturity model	A model that contains the essential elements of effective processes for one or more disciplines and describes an evolutionary improvement path from ad hoc, immature processes to disciplined, mature processes with improved quality and effectiveness.
capable process	A process that can satisfy its specified product quality, service quality, and process-performance objectives. (See also “stable process,” “standard process,” and “statistically managed process.”)
causal analysis	The analysis of defects to determine their cause.
change management	Judicious use of means to effect a change, or a proposed change, to a product or service. (See also “configuration management.”)
CMMI Framework	The basic structure that organizes CMMI components, including elements of current CMMI models as well as rules and methods for generating models, appraisal methods (including associated artifacts), and training materials. The framework enables new disciplines to be added to CMMI so that they will integrate with the existing ones. (See also “CMMI model” and “CMMI Product Suite.”)
CMMI model	A model generated from the CMMI Framework. (See also “CMMI Framework” and “CMMI Product Suite.”)
CMMI model component	Any of the main architectural elements that compose a CMMI model. Some of the main elements of a CMMI model include specific practices, generic practices, specific goals, generic goals, process areas, capability levels, and maturity levels.
CMMI Product Suite	The complete set of products developed around the CMMI concept. These products include the framework itself, models, appraisal methods, appraisal materials, and training materials. (See also “CMMI Framework” and “CMMI model.”)
common cause of process variation	The variation of a process that exists because of normal and expected interactions among components of a process. (See also “special cause of process variation.”)
concept of operations	(See “operational concept.”)

configuration audit	An audit conducted to verify that a configuration item, or a collection of configuration items that make up a baseline, conforms to a specified standard or requirement. (See also "audit," "configuration item," "functional configuration audit," and "physical configuration audit.")
configuration baseline	The configuration information formally designated at a specific time during a product's or product component's life. Configuration baselines, plus approved changes from those baselines, constitute the current configuration information. (See also "product lifecycle.")
configuration control	An element of configuration management consisting of the evaluation, coordination, approval or disapproval, and implementation of changes to configuration items after formal establishment of their configuration identification. (See also "configuration identification," "configuration item," and "configuration management.")
configuration control board	A group of people responsible for evaluating and approving or disapproving proposed changes to configuration items and for ensuring implementation of approved changes. (See also "configuration item.")
	Configuration control boards are also known as change control boards.
configuration identification	An element of configuration management consisting of selecting the configuration items for a product, assigning unique identifiers to them, and recording their functional and physical characteristics in technical documentation. (See also "configuration item," "configuration management," and "product.")
configuration item	An aggregation of work products that is designated for configuration management and treated as a single entity in the configuration management process. (See also "configuration management.")
configuration management	A discipline applying technical and administrative direction and surveillance to (1) identify and document the functional and physical characteristics of a configuration item, (2) control changes to those characteristics, (3) record and report change processing and implementation status, and (4) verify compliance with specified requirements. (See also "configuration audit," "configuration control," "configuration identification," and "configuration status accounting.")

configuration status accounting	An element of configuration management consisting of the recording and reporting of information needed to manage a configuration effectively. This information includes a list of the approved configuration, the status of proposed changes to the configuration, and the implementation status of approved changes. (See also “configuration identification” and “configuration management.”)
continuous representation	A capability maturity model structure wherein capability levels provide a recommended order for approaching process improvement within each specified process area. (See also “capability level,” “process area,” and “staged representation.”)
contractual requirements	The result of the analysis and refinement of customer requirements into a set of requirements suitable to be included in one or more solicitation packages, formal contracts, or supplier agreements between the acquirer and other appropriate organizations. (See also “acquirer,” “customer requirement,” “supplier agreement,” and “solicitation package.”)
	Contractual requirements include both technical and nontechnical requirements necessary for the acquisition of a product or service.
corrective action	Acts or deeds used to remedy a situation, remove an error, or adjust a condition.
commercial off-the-shelf	Items that can be purchased from a commercial supplier.
customer	The party (individual, project, or organization) responsible for accepting the product or for authorizing payment. The customer is external to the project (except possibly when integrated teams are used) but not necessarily external to the project’s organization. The customer may be a higher level project. Customers are a subset of stakeholders. (See also “stakeholder.”)
	In most cases where this term is used, the preceding definition is intended; however, in some contexts, the term “customer” is intended to include other relevant stakeholders. (See also “customer requirement.”)
customer requirement	The result of eliciting, consolidating, and resolving conflicts among the needs, expectations, constraints, and interfaces of the product’s relevant stakeholders in a way that is acceptable to the customer. (See also “customer.”)

data	Recorded information, regardless of the form or method of recording, including technical data, computer software documents, financial information, management information, representation of facts, numbers, or datum of any nature that can be communicated, stored, and processed.
data management	The disciplined processes and systems that plan for, acquire, and provide stewardship for business and technical data, consistent with data requirements, throughout the data lifecycle.
defect density	Number of defects per unit of product size (e.g., problem reports per thousand lines of code).
defined process	A managed process that is tailored from the organization's set of standard processes according to the organization's tailoring guidelines; has a maintained process description; and contributes work products, measures, and other process improvement information to organizational process assets. (See also "managed process" and "measure.")
deliverable	An item to be provided to an acquirer or other designated recipient as specified in an agreement. This item can be a document, hardware item, software item, service, or any type of work product. (See also "acquirer.")
derived measure	Measure that is defined as a function of two or more values of base measures. (See also "base measure.")
derived requirements	Requirements that are not explicitly stated in customer requirements but are inferred (1) from contextual requirements (e.g., applicable standards, laws, policies, common practices, and management decisions) or (2) from requirements needed to specify a product or service component. Derived requirements can also arise during analysis and design of components of the product or service. (See also "product requirements.")
design review	A formal, documented, comprehensive, and systematic examination of a design to determine if the design meets the applicable requirements, to identify problems, and to propose solutions.
development	In the CMMI Product Suite, not only development activities but also maintenance activities. Development projects that benefit from CMMI best practices can focus on development, maintenance, or both.

development plan	A plan for guiding, implementing, and controlling the design and development of one or more products or services. (See also “product lifecycle” and “project plan.”)
discipline	In the CMMI Product Suite, the bodies of knowledge available when selecting a CMMI model (e.g., systems engineering). The CMMI Product Team envisions that other bodies of knowledge will be integrated into the CMMI Framework in the future.
document	A collection of data, regardless of the medium on which it is recorded, that generally has permanence and can be read by humans or machines. So, documents include both paper and electronic documents.
enterprise	The full composition of a company. A company may consist of many organizations in many locations with different customers. (See also “organization.”)
entry criteria	States of being that must be present before an effort can begin successfully.
equivalent staging	A target staging, created using the continuous representation, which is defined so that the results of using the target staging can be compared to maturity levels of the staged representation. (See also “capability level profile,” “maturity level,” “target profile,” and “target staging.”)
	Such staging permits benchmarking of progress among organizations, enterprises, and projects, regardless of the CMMI representation used. The organization may implement components of CMMI models beyond those reported as part of equivalent staging. Equivalent staging is only a measure to relate how the organization is compared to other organizations in terms of maturity levels.
establish and maintain	This phrase means more than a combination of its component terms; it includes documentation and usage. For example, “Establish and maintain an organizational policy for planning and performing the organizational process focus process” means that not only must a policy be formulated, but it also must be documented and it must be used throughout the organization.
evidence	(See “objective evidence.”)
executive	(See “senior manager.”)
exit criteria	States of being that must be present before an effort can end successfully.

expected CMMI components	CMMI components that explain what may be done to satisfy a required CMMI component. Model users can implement the expected components explicitly or implement equivalent alternative practices to these components. Specific and generic practices are expected model components.
findings	(See “appraisal findings.”)
formal evaluation process	A structured approach to evaluating alternative solutions against established criteria to determine a recommended solution to address an issue.
framework	(See “CMMI Framework.”)
functional analysis	Examination of a defined function to identify all the subfunctions necessary to accomplish that function; identification of functional relationships and interfaces (internal and external) and capturing these in a functional architecture; and flow down of upper level performance requirements and assignment of these requirements to lower level subfunctions. (See also “functional architecture.”)
functional architecture	The hierarchical arrangement of functions, their internal and external (external to the aggregation itself) functional interfaces and external physical interfaces, their respective functional and performance requirements, and their design constraints.
functional configuration audit	An audit conducted to verify that the development of a configuration item has been completed satisfactorily, that the item has achieved the performance and functional characteristics specified in the functional or allocated configuration identification, and that its operational and support documents are complete and satisfactory. (See also “configuration audit,” “configuration management,” and “physical configuration audit.”)
generic goal	A required model component that describes characteristics that must be present to institutionalize processes that implement a process area. (See also “institutionalization.”)
generic practice	An expected model component that is considered important in achieving the associated generic goal. The generic practices associated with a generic goal describe the activities that are expected to result in achievement of the generic goal and contribute to the institutionalization of the processes associated with a process area.

generic practice elaboration	An informative model component that appears after a generic practice to provide guidance on how the generic practice should be applied to the process area. (This model component is not present in all CMMI models.)
goal	A required CMMI component that can be either a generic goal or a specific goal. The word goal in a CMMI model always refers to a model component (e.g., generic goal and specific goal). (See also “generic goal,” “objective,” and “specific goal.”)
hardware engineering	The application of a systematic, disciplined, and quantifiable approach to transforming a set of requirements that represent the collection of stakeholder needs, expectations, and constraints, using documented techniques and technology to design, implement, and maintain a tangible product. (See also “software engineering” and “systems engineering.”)
	In CMMI, hardware engineering represents all technical fields (e.g., electrical or mechanical) that transform requirements and ideas into tangible and producible products.
higher level management	The person or persons who provide the policy and overall guidance for the process but do not provide the direct day-to-day monitoring and controlling of the process. Such persons belong to a level of management in the organization above the immediate level responsible for the process and can be (but are not necessarily) senior managers. (See also “senior manager.”)
incomplete process	A process that is not performed or is performed only partially (also known as capability level 0). One or more of the specific goals of the process area are not satisfied.
informative CMMI components	CMMI components that help model users understand the required and expected components of a model. These components can contain examples, detailed explanations, or other helpful information. Subpractices, notes, references, goal titles, practice titles, sources, typical work products, amplifications, and generic practice elaborations are informative model components.
institutionalization	The ingrained way of doing business that an organization follows routinely as part of its corporate culture.

integrated team	A group of people with complementary skills and expertise who are committed to delivering specified work products in timely collaboration. Integrated team members provide skills and advocacy appropriate to all phases of the work products' life and are collectively responsible for delivering work products as specified. An integrated team should include empowered representatives from organizations, disciplines, and functions that have a stake in the success of the work products.
interface control	In configuration management, the process of (1) identifying all functional and physical characteristics relevant to the interfacing of two or more configuration items provided by one or more organizations and (2) ensuring that proposed changes to these characteristics are evaluated and approved prior to implementation. (See also "configuration item" and "configuration management.")
lifecycle model	A partitioning of the life of a product, service, or project into phases.
managed process	A performed process that is planned and executed in accordance with policy; employs skilled people having adequate resources to produce controlled outputs; involves relevant stakeholders; is monitored, controlled, and reviewed; and is evaluated for adherence to its process description. (See also "performed process.")
manager	In the CMMI Product Suite, a person who provides technical and administrative direction and control to those performing tasks or activities within the manager's area of responsibility. The traditional functions of a manager include planning, organizing, directing, and controlling work within an area of responsibility.
maturity level	Degree of process improvement across a predefined set of process areas in which all goals in the set are attained. (See also "capability level" and "process area.")
measure (noun)	Variable to which a value is assigned as a result of measurement. (See also "base measure," "derived measure," and "measurement.")
measurement	A set of operations to determine the value of a measure. (See also "measure.")
memorandum of agreement	Binding document of understanding or agreement between two or more parties. Also known as a "memorandum of understanding."

natural bounds	The inherent process reflected by measures of process performance; sometimes referred to as “voice of the process.”
	Techniques such as control charts, confidence intervals, and prediction intervals are used to determine whether the variation is due to common causes (i.e., the process is predictable or stable) or is due to some special cause that can and should be identified and removed. (See also “measure” and “process performance.”)
nondevelopmental item	An item that was developed prior to its current use in an acquisition or development process. Such an item may require minor modifications to meet the requirements of its current intended use.
nontechnical requirements	Requirements affecting product and service acquisition or development that are not properties of the product or service.
	Examples include numbers of products or services to be delivered, data rights for delivered COTS nondevelopmental items, delivery dates, and milestones with exit criteria. Other nontechnical requirements include work constraints associated with training, site provisions, and deployment schedules.
objective	When used as a noun in the CMMI Product Suite, the term <i>objective</i> replaces the word <i>goal</i> as used in its common everyday sense, since the word <i>goal</i> is reserved for use when referring to CMMI model components called <i>specific goals</i> and <i>generic goals</i> . (See also “goal.”)
objective evidence	As used in CMMI appraisal materials, documents or interview results used as indicators of the implementation or institutionalization of model practices. Sources of objective evidence can include instruments, presentations, documents, and interviews. (See also “institutionalization.”)
objectively evaluate	To review activities and work products against criteria that minimize subjectivity and bias by the reviewer. An example of an objective evaluation is an audit against requirements, standards, or procedures by an independent quality assurance function. (See also “audit.”)
observation	As used in CMMI appraisal materials, a written record that represents the appraisal team members’ understanding of information either seen or heard during appraisal data collection activities. The written record may take the form of a statement or may take alternative forms as long as the content is preserved.

operational concept	A general description of the way in which an entity is used or operates. (Also known as “concept of operations.”)
operational scenario	A description of an imagined sequence of events that includes the interaction of the product or service with its environment and users, as well as interaction among its product or service components. Operational scenarios are used to evaluate the requirements and design of the system and to verify and validate the system.
optimizing process	A quantitatively managed process that is improved based on an understanding of the common causes of variation inherent in the process. The focus of an optimizing process is on continually improving the range of process performance through both incremental and innovative improvements. (See also “common cause of process variation,” “defined process,” and “quantitatively managed process.”)
organization	An administrative structure in which people collectively manage one or more projects as a whole and whose projects share a senior manager and operate under the same policies. However, the word <i>organization</i> as used throughout CMMI models can also apply to one person who performs a function in a small organization that might be performed by a group of people in a large organization. (See also “enterprise” and “organizational unit.”)
organizational maturity	The extent to which an organization has explicitly and consistently deployed processes that are documented, managed, measured, controlled, and continually improved. Organizational maturity may be measured via appraisals.
organizational policy	A guiding principle typically established by senior management that is adopted by an organization to influence and determine decisions.
organizational process assets	Artifacts that relate to describing, implementing, and improving processes (e.g., policies, measurements, process descriptions, and process implementation support tools). The term <i>process assets</i> is used to indicate that these artifacts are developed or acquired to meet the business objectives of the organization and that they represent investments by the organization that are expected to provide current and future business value. (See also “process asset library.”)

organizational unit	The part of an organization that is the subject of an appraisal. An organizational unit deploys one or more processes that have a coherent process context and operates within a coherent set of business objectives. An organizational unit is typically part of a larger organization, although in a small organization the organizational unit may be the whole organization.
organization's business objectives	Senior management developed strategies designed to ensure an organization's continued existence and enhance its profitability, market share, and other factors influencing the organization's success. (See also "quality and process-performance objectives" and "quantitative objective.") Such objectives may include reducing the number of change requests during a system's integration phase, reducing development cycle time, increasing the number of errors found in a product's first or second phase of development, and reducing the number of customer-reported defects when applied to systems engineering activities.
organization's measurement repository	A repository used to collect and make measurement data available on processes and work products, particularly as they relate to the organization's set of standard processes. This repository contains or references actual measurement data and related information needed to understand and analyze measurement data.
organization's process asset library	A library of information used to store and make process assets available that are useful to those who are defining, implementing, and managing processes in the organization. This library contains process assets that include process-related documentation such as policies, defined processes, checklists, lessons-learned documents, templates, standards, procedures, plans, and training materials.
organization's set of standard processes	A collection of definitions of the processes that guide activities in an organization. These process descriptions cover the fundamental process elements (and their relationships to each other, such as ordering and interfaces) that must be incorporated into the defined processes that are implemented in projects across the organization. A standard process enables consistent development and maintenance activities across the organization and is essential for long-term stability and improvement. (See also "defined process" and "process element.")
outsourcing	(See "acquisition.")

peer review	The review of work products performed by peers during development of the work products to identify defects for removal. The term <i>peer review</i> is used in the CMMI Product Suite instead of the term <i>work product inspection</i> . (See also “work product.”)
performed process	A process that accomplishes the needed work to produce work products. The specific goals of the process area are satisfied.
physical configuration audit	An audit conducted to verify that a configuration item, as built, conforms to the technical documentation that defines and describes it. (See also “configuration audit,” “configuration management,” and “functional configuration audit.”)
planned process	A process that is documented by both a description and a plan. The description and plan should be coordinated, and the plan should include standards, requirements, objectives, resources, and assignments.
policy	(See “organizational policy.”)
process	In the CMMI Product Suite, activities that can be recognized as implementations of practices in a CMMI model. These activities can be mapped to one or more practices in CMMI process areas to allow a model to be useful for process improvement and process appraisal. (See also “process area,” “subprocess,” and “process element.”)
	There is a special use of the phrase <i>the process</i> in the statements and descriptions of the generic goals and generic practices. <i>The process</i> , as used in Part Two, is the process or processes that implement the process area.
process action plan	A plan, usually resulting from appraisals, that documents how specific improvements targeting the weaknesses uncovered by an appraisal will be implemented.
process action team	A team that has the responsibility to develop and implement process improvement activities for an organization as documented in a process action plan.
process and technology improvements	Incremental and innovative improvements to processes and to process, product, or service technologies.

process architecture	The ordering, interfaces, interdependencies, and other relationships among the process elements in a standard process. Process architecture also describes the interfaces, interdependencies, and other relationships between process elements and external processes (e.g., contract management).
process area	A cluster of related practices in an area that, when implemented collectively, satisfies a set of goals considered important for making improvement in that area. All CMMI process areas are common to both continuous and staged representations.
process asset	Anything the organization considers useful in attaining the goals of a process area. (See also “organizational process assets.”)
process asset library	A collection of process asset holdings that can be used by an organization or project. (See also “organization’s process asset library.”)
process attribute	A measurable characteristic of process capability applicable to any process.
process capability	The range of expected results that can be achieved by following a process.
process context	The set of factors, documented in the appraisal input, that influences the judgment and comparability of appraisal ratings.
	These factors include but are not limited to (a) the size of the organizational unit to be appraised; (b) the demographics of the organizational unit; (c) the application domain of the products or services; (d) the size, criticality, and complexity of the products or services; and (e) the quality characteristics of the products or services.
process definition	The act of defining and describing a process. The result of process definition is a process description. (See also “process description.”)

process description	A documented expression of a set of activities performed to achieve a given purpose.
	A process description provides an operational definition of the major components of a process. The description specifies, in a complete, precise, and verifiable manner, the requirements, design, behavior, or other characteristics of a process. It also may include procedures for determining whether these provisions have been satisfied. Process descriptions can be found at the activity, project, or organizational level.
process element	The fundamental unit of a process. A process can be defined in terms of subprocesses or process elements. A subprocess can be further decomposed into subprocesses or process elements; a process element cannot. (See also "process" and "subprocess.")
	Each process element covers a closely related set of activities (e.g., estimating element and peer review element). Process elements can be portrayed using templates to be completed, abstractions to be refined, or descriptions to be modified or used. A process element can be an activity or task.
process group	A collection of specialists who facilitate the definition, maintenance, and improvement of processes used by the organization.
process improvement	A program of activities designed to improve the performance and maturity of the organization's processes, and the results of such a program.
process improvement objectives	A set of target characteristics established to guide the effort to improve an existing process in a specific, measurable way either in terms of resultant product or service characteristics (e.g., quality, performance, and conformance to standards) or in the way in which the process is executed (e.g., elimination of redundant process steps, combination of process steps, and improvement of cycle time). (See also "organization's business objectives" and "quantitative objective.")
process improvement plan	A plan for achieving organizational process improvement objectives based on a thorough understanding of current strengths and weaknesses of the organization's processes and process assets.
process measurement	A set of operations used to determine values of measures of a process and its resulting products or services for the purpose of characterizing and understanding the process. (See also "measurement.")

process owner	The person (or team) responsible for defining and maintaining a process. At the organizational level, the process owner is the person (or team) responsible for the description of a standard process; at the project level, the process owner is the person (or team) responsible for the description of the defined process. A process may therefore have multiple owners at different levels of responsibility. (See also “defined process” and “standard process.”)
process performance	A measure of actual results achieved by following a process. It is characterized by both process measures (e.g., effort, cycle time, and defect removal efficiency) and product or service measures (e.g., reliability, defect density, and response time). (See also “measure.”)
process-performance baseline	A documented characterization of actual results achieved by following a process, which is used as a benchmark for comparing actual process performance against expected process performance. (See also “process performance.”)
process-performance model	A description of relationships among attributes of a process and its work products that is developed from historical process-performance data and calibrated using collected process and product or service measures from the project and that are used to predict results to be achieved by following a process. (See also “measure.”)
process tailoring	Making, altering, or adapting a process description for a particular end. For example, a project tailors its defined process from the organization’s set of standard processes to meet objectives, constraints, and the environment of the project. (See also “defined process,” “organization’s set of standard processes,” and “process description.”)
product	In the CMMI Product Suite, a work product that is intended for delivery to a customer or end user. The form of a product can vary in different contexts. (See also “customer,” “product component,” “service” and “work product.”)
product component	In the CMMI Product Suite, a work product that is a lower level component of the product. Product components are integrated to produce the product. There may be multiple levels of product components. (See also “product” and “work product.”)
Throughout the process areas, where the terms <i>product</i> and <i>product component</i> are used, they are intended to include service and service component and should be interpreted in that way.	

product component requirements	A complete specification of a product or service component, including fit, form, function, performance, and any other requirement.
product lifecycle	The period of time, consisting of phases, that begins when a product or service is conceived and ends when the product or service is no longer available for use. Since an organization may be producing multiple products or services for multiple customers, one description of a product lifecycle may not be adequate. Therefore, the organization may define a set of approved product lifecycle models. These models are typically found in published literature and are likely to be tailored for use in an organization.
	A product lifecycle could consist of the following phases: (1) concept and vision, (2) feasibility, (3) design/development, (4) production, and (5) phase out.
product line	A group of products or services sharing a common, managed set of features that satisfy specific needs of a selected market or mission.
product-related lifecycle processes	Processes associated with a product or service throughout one or more phases of its life (e.g., from conception through disposal), such as manufacturing and support processes.
product requirements	A refinement of customer requirements into the developers' language, making implicit requirements into explicit derived requirements. (See also "derived requirements" and "product component requirements.")
	The developer uses product requirements to guide the design and building of the product or service.
product suite	(See "CMMI Product Suite.")
profile	(See "achievement profile" and "target profile.")
program	(1) A project. (2) A collection of related projects and the infrastructure that supports them, including objectives, methods, activities, plans, and success measures. (See also "project.")

project	In the CMMI Product Suite, a managed set of interrelated resources that delivers one or more products or services to a customer or end user. A project has a definite beginning (i.e., project startup) and typically operates according to a plan. Such a plan is frequently documented and specifies what is to be delivered or implemented, the resources and funds to be used, the work to be done, and a schedule for doing the work. A project can be composed of projects. (See also “project startup.”)
project manager	In the CMMI Product Suite, the person responsible for planning, directing, controlling, structuring, and motivating the project. The project manager is responsible for satisfying the customer.
project plan	A plan that provides the basis for performing and controlling the project’s activities, which addresses the commitments to the project’s customer.
	Project planning includes estimating the attributes of work products and tasks, determining the resources needed, negotiating commitments, producing a schedule, and identifying and analyzing project risks. Iterating through these activities may be necessary to establish the project plan.
project progress and performance	What a project achieves with respect to implementing project plans, including effort, cost, schedule, and technical performance. (See also “technical performance.”)
project startup	When a set of interrelated resources are directed to develop or deliver one or more products or services for a customer or end user. (See also “project.”)
project’s defined process	The integrated and defined process that is tailored from the organization’s set of standard processes. (See also “defined process.”)

prototype	<p>A preliminary type, form, or instance of a product, service, product component, or service component that serves as a model for later stages or for the final, complete version of the product or service.</p> <p>This model (e.g., physical, electronic, digital, and analytical) can be used for the following (and other) purposes:</p> <ul style="list-style-type: none"> • Assessing the feasibility of a new or unfamiliar technology • Assessing or mitigating technical risk • Validating requirements • Demonstrating critical features • Qualifying a product or service • Qualifying a process • Characterizing performance or features of the product or service • Elucidating physical principles
quality	The ability of a set of inherent characteristics of a product, service, product component, service component, or process to fulfill requirements of customers.
quality and process-performance objectives	<p>Objectives and requirements for product quality, service quality, and process performance.</p> <p>Process-performance objectives include quality; however, to emphasize the importance of quality in the CMMI Product Suite, the phrase quality and process-performance objectives is used rather than just process-performance objectives.</p>
quality assurance	A planned and systematic means for assuring management that the defined standards, practices, procedures, and methods of the process are applied.
quantitative objective	Desired target value expressed as quantitative measures. (See also “measure,” “process improvement objectives,” and “quality and process-performance objectives.”)
quantitatively managed process	A defined process that is controlled using statistical and other quantitative techniques. The product quality, service quality, and process-performance attributes are measurable and controlled throughout the project. (See also “defined process,” “optimizing process,” and “statistically managed process.”)
rating	(See “appraisal rating.”)

reference	An informative model component that points to additional or more detailed information in related process areas.
reference model	A model that is used as a benchmark for measuring an attribute.
relevant stakeholder	A stakeholder that is identified for involvement in specified activities and is included in a plan. (See also “stakeholder.”)
representation	The organization, use, and presentation of a CMM’s components. Overall, two types of approaches to presenting best practices are evident: the staged representation and the continuous representation.
required CMMI components	CMMI components that are essential to achieving process improvement in a given process area. These components are used in appraisals to determine process capability. Specific goals and generic goals are required model components.
requirement	(1) A condition or capability needed by a user to solve a problem or achieve an objective. (2) A condition or capability that must be met or possessed by a product, service, product component, or service component to satisfy a supplier agreement, standard, specification, or other formally imposed documents. (3) A documented representation of a condition or capability as in (1) or (2). (See also “supplier agreement.”)
requirements analysis	The determination of product- or service-specific performance and functional characteristics based on analyses of customer needs, expectations, and constraints; operational concept; projected utilization environments for people, products, services, and processes; and measures of effectiveness. (See also “operational concept.”)
requirements elicitation	Using systematic techniques, such as prototypes and structured surveys, to proactively identify and document customer and end-user needs.
requirements management	The management of all requirements received by or generated by the project, including both technical and nontechnical requirements as well as those requirements levied on the project by the organization. (See also “nontechnical requirement.”)
requirements traceability	A discernable association between requirements and related requirements, implementations, and verifications. (See also “bidirectional traceability” and “traceability.”)

return on investment	The ratio of revenue from output (product or service) to production costs, which determines whether an organization benefits from performing an action to produce something.
risk analysis	The evaluation, classification, and prioritization of risks.
risk identification	An organized, thorough approach to seek out probable or realistic risks in achieving objectives.
risk management	An organized, analytic process to identify what might cause harm or loss (identify risks); to assess and quantify the identified risks; and to develop and, if needed, implement an appropriate approach to prevent or handle causes of risk that could result in significant harm or loss.
risk management strategy	An organized, technical approach to identify what might cause harm or loss (identify risks); to assess and quantify the identified risks; and to develop and, if needed, implement an appropriate approach to prevent or handle causes of risk that could result in significant harm or loss.
	Typically, risk management is performed for project, organization, or product or service developing organizational units.
root cause	A source of a defect such that if it is removed, the defect is decreased or removed.
senior manager	In the CMMI Product Suite, a management role at a high enough level in an organization that the primary focus of the person filling the role is the long-term vitality of the organization rather than short-term project concerns and pressures. A senior manager has authority to direct the allocation or reallocation of resources in support of organizational process improvement effectiveness. (See also "higher level management.") A senior manager can be any manager who satisfies this description, including the head of the organization. Synonyms for senior manager include executive and top-level manager. However, to ensure consistency and usability, these synonyms are not used in CMMI models.
service	In the CMMI Product Suite, a service is a product that is intangible and non-storable. (See also "product," "customer," and "work product.")
service level	Current performance related to an agreed-on service level measure. (See also "measure" and "service.")

service level agreement	Written agreement that documents agreed-on performance targets for agreed-on service level measures. (See also “measure” and “service.”)
service level measure	Measure of service performance that can be used as a target for acceptable results or behavior. (See also “measure” and “service.”)
shared vision	A common understanding of guiding principles, including mission, objectives, expected behavior, values, and final outcomes, which are developed and used by a project.
software engineering	(1) The application of a systematic, disciplined, quantifiable approach to the development, operation, and maintenance of software. (2) The study of approaches as in (1). (See also “hardware engineering,” and “systems engineering.”)
solicitation	The process of preparing a package to be used in selecting a supplier. (See also “solicitation package.”)
solicitation package	A collection of formal documents that includes a description of the desired form of response from a potential supplier, the relevant statement of work for the supplier, and required provisions in the supplier agreement.
special cause of process variation	A cause of a defect that is specific to some transient circumstance and is not an inherent part of a process. (See also “common cause of process variation.”)
specific goal	A required model component that describes the unique characteristics that must be present to satisfy the process area. (See also “capability level,” “generic goal,” “organization’s business objectives,” and “process area.”)
specific practice	An expected model component that is considered important in achieving the associated specific goal. The specific practices describe the activities expected to result in achievement of the specific goals of a process area. (See also “process area” and “specific goal.”)
stable process	The state in which all special causes of process variation have been removed and prevented from recurring so that only common causes of process variation of the process remain. (See also “capable process,” “common cause of process variation,” “special cause of process variation,” “standard process,” and “statistically managed process.”)

staged representation	A model structure wherein attaining the goals of a set of process areas establishes a maturity level; each level builds a foundation for subsequent levels. (See also “maturity level” and “process area.”)
stakeholder	In the CMMI Product Suite, a group or individual that is affected by or is in some way accountable for the outcome of an undertaking. Stakeholders may include project members, suppliers, customers, end users, and others. (See also “customer” and “relevant stakeholder.”)
standard (noun)	<p>Formal requirements developed and used to prescribe consistent approaches to development (e.g., ISO/IEC standards, IEEE standards, and organizational standards).</p> <p>Instead of using <i>standard</i> as an adjective in its common everyday sense, we use another term that means the same thing (e.g., typical, traditional, usual, or customary).</p>
standard process	<p>An operational definition of the basic process that guides the establishment of a common process in an organization.</p> <p>A standard process describes the fundamental process elements that are expected to be incorporated into any defined process. It also describes relationships (e.g., ordering and interfaces) among these process elements. (See also “defined process.”)</p>
statement of work	A description of work to be performed.
statistical predictability	The performance of a quantitative process that is controlled using statistical and other quantitative techniques.
statistical process control	Statistically based analysis of a process and measures of process performance, which identify common and special causes of variation in process performance and maintain process performance within limits. (See also “common cause of process variation,” “special cause of process variation,” and “statistically managed process.”)
statistical techniques	An analytic technique that employs statistical methods (e.g., statistical process control, confidence intervals, and prediction intervals).

statistically managed process	A process that is managed by a statistically based technique in which processes are analyzed, special causes of process variation are identified, and performance is contained within well-defined limits. (See also “capable process,” “special cause of process variation,” “stable process,” “standard process,” and “statistical process control.”)
subpractice	An informative model component that provides guidance for interpreting and implementing specific or generic practices. Subpractices may be worded as if prescriptive, but they are actually meant only to provide ideas that may be useful for process improvement.
subprocess	A process that is part of a larger process. A subprocess can be decomposed into subprocesses and/or process elements. (See also “process,” “process description,” and “process element.”)
supplier	(1) An entity delivering products or performing services being acquired. (2) An individual, partnership, company, corporation, association, or other service having an agreement with an acquirer for the design, development, manufacture, maintenance, modification, or supply of items under the terms of an agreement. (See also “acquirer.”)
supplier agreement	A documented agreement between the acquirer and supplier (e.g., contract, license, or memorandum of agreement).
sustainment	The processes used to ensure that a product or service remains operational.
systems engineering	The interdisciplinary approach governing the total technical and managerial effort required to transform a set of customer needs, expectations, and constraints into a solution and to support that solution throughout its life. (See also “hardware engineering” and “software engineering.”)
	This approach includes the definition of technical performance measures, the integration of engineering specialties toward the establishment of an architecture, and the definition of supporting lifecycle processes that balance cost, performance, and schedule objectives.
system of systems	A set or arrangement of systems that results when independent and useful systems are integrated into a large system that delivers unique capabilities.

tailoring	Tailoring a process makes, alters, or adapts a process description for a particular end. For example, a project establishes its defined process by tailoring from the organization's set of standard processes to meet the objectives, constraints, and environment of the project.
tailoring guidelines	Organizational guidelines that enable projects, groups, and organizational functions to appropriately adapt standard processes for their use. The organization's set of standard processes is described at a general level that may not be directly usable to perform a process.
	Tailoring guidelines aid those who establish the defined processes for projects. Tailoring guidelines cover (1) selecting a standard process, (2) selecting an approved lifecycle model, and (3) tailoring the selected standard process and lifecycle model to fit project needs. Tailoring guidelines describe what can and cannot be modified and identify process components that are candidates for modification.
target profile	In the continuous representation, a list of process areas and their corresponding capability levels that represent an objective for process improvement. (See also "achievement profile" and "capability level profile.")
target staging	In the continuous representation, a sequence of target profiles that describes the path of process improvement to be followed by the organization. (See also "achievement profile," "capability level profile," and "target profile.")
technical performance	Characteristic of a process, product, or service, generally defined by a functional or technical requirement (e.g., estimating accuracy, user functions, security functions, response time, component accuracy, maximum weight, minimum throughput, and allowable range).
technical performance measure	Precisely defined technical measure of a requirement, capability, or some combination of requirements and capabilities. (See also "measure.")
technical requirements	Properties (i.e., attributes) of products or services to be acquired or developed.
test procedure	Detailed instructions for the setup, execution, and evaluation of results for a given test.
traceability	A discernable association among two or more logical entities such as requirements, system elements, verifications, or tasks. (See also "bidirectional traceability" and "requirements traceability.")

trade study	An evaluation of alternatives, based on criteria and systematic analysis, to select the best alternative for attaining determined objectives.
training	Formal and informal learning options, which may include in-class training, informal mentoring, Web-based training, guided self-study, and formalized on-the-job training programs. The learning options selected for each situation are based on an assessment of the need for training and the performance gap to be addressed.
typical work product	An informative model component that provides sample outputs from a specific practice. These examples are called typical work products because there are often other work products that are just as effective but are not listed.
unit testing	Testing of individual hardware or software units or groups of related units. (See also “acceptance testing.”)
validation	Confirmation that the product or service, as provided (or as it will be provided), will fulfill its intended use. In other words, validation ensures that “you built the right thing.” (See also “verification.”)
verification	Confirmation that work products properly reflect the requirements specified for them. In other words, verification ensures that “you built it right.” (See also “validation.”)
version control	The establishment and maintenance of baselines and the identification of changes to baselines that make it possible to return to the previous baseline.
work breakdown structure (WBS)	An arrangement of work elements, and their relationship to each other and to the end product or service.
work product	In the CMMI Product Suite, a useful result of a process. This can include files, documents, products, parts of a product, services, process descriptions, specifications, and invoices. A key distinction between a work product and a product component is that a work product is not necessarily part of the end product. (See also “product” and “product component.”)
	In CMMI models, the definition of “work product” includes services, however, the phrase “work products and services” is used to emphasize the inclusion of services in the discussion.

work product and task attributes

Characteristics of products, services, and project tasks used to help in estimating project work. These characteristics include items such as size, complexity, weight, form, fit, and function. They are typically used as one input to deriving other project and resource estimates (e.g., effort, cost, and schedule).

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<p>13. ABSTRACT (MAXIMUM 200 WORDS)</p> <p>CMMI for Acquisition (CMMI-ACQ) is a model that provides guidance to acquisition organizations for initiating and managing the acquisition of products and services. The model focuses on acquirer processes and integrates bodies of knowledge that are essential for successful acquisitions</p> <p>CMMI-ACQ provides an opportunity for acquisition organizations</p> <ul style="list-style-type: none"> • to avoid or eliminate barriers and problems in the acquisition process through improved operational efficiencies • to initiate and manage a process for acquiring products and services, including solicitations, supplier sourcing, supplier agreement development and award, and supplier capability management • to utilize a common language for both acquirers and suppliers so that quality solutions are delivered more quickly and at a lower cost with the most appropriate technology 			
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